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Forthcoming Events.

NOVEMBER 26-DECEMBER 5.

Cardiff Engineering Exhibition:—Exhibition organised by the South Wales Institute of Engineers at the Drill Hall, Dumfries Place.

NOVEMBER 27.

Institution of Engineering Inspection:—Annual reception and presidential address, in London.

Institution of Automobile Engineers:—Conference at the Olympia.

Institution of Mechanical Engineers:—Informal meeting in London.

Institution of Production Engineers:—General meeting in London. "Fundamentals of Jig and Special Purpose Machine Design, with Special Reference to Automobile Manufacture," Paper by E. W. Hancock.

NOVEMBER 28.

Institute of British Foundrymen (Wales and Monmouth Branch):—Ordinary meeting at Newport. "Cast Iron," Paper by C. A. Howe.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Perlit Correspondence.

We do not feel that the publication of the recent correspondence has been productive of much of material interest, and we believe that if correspondents would stick to the points at issue better progress would be made. Primarily, "A Foundry Director" insisted that a certain amount of mystery surrounded the whole of the process and its exploitation. That, to our mind, cannot be substantiated, as the master patent and a number of patents of addition are available for purchase from H.M. Patent Office. The composition of the directorate has been published in both the technical and business Press. At the moment the material is being shown at the Shipping, Engineering and Machinery Exhibition, where as many facilities as can be given under exhibition conditions for appraising the value of the material are given.

A really interesting question has been brought out in the correspondence as to whether a high tensile iron is the most suitable cast iron alloy for Diesel engine work. We incline to the belief that it is not, but, in fairness to Perlit, it should be borne in mind that high tensile test results are not the *alpha* and *omega* of the process, but rather is the maximum value to be associated with equality of grain throughout section.

How are large moulds of unequal section to be uniformly heated is, of course, of paramount practical importance. A point which strikes us as being of importance is the fact that the moulds must be heated to a certain extent by the liquid iron during the filling. After all, looking at this question large and broad, one can reasonably ask, is it, as a problem, more difficult to solve than, say, the manufacture and transport of a stern frame casting for an Atlantic liner?

Whether chairmen stifle discussions in technical meetings is very far removed from the question under consideration. From our very considerable experience of such meetings, it can be definitely stated that such conditions are few and far between, and are probably balanced by the placing of extra sessions where discussions are left unfinished.

Mr. J. E. Hurst's constant requests for samples of Perlit iron showing a white fracture when cast normally (that is, into cold moulds), has now been answered by the declarations of Mr. Longden and Mr. Richman, both of whom are independent experimenters.

The latest phase of the correspondence is a letter from "A Foundry Metallurgist," who introduces a comparison with another special iron. This is rather unfair, as courtesy will prevent the interested parties from discussing what may be thought by some to be a rival process. The Thyssen-Emmel iron is to be associated with a low total carbon, high silicon, and high manganese, whereas Perlit is a low silicon material. Exceptionally high tensile tests have been obtained with the former, and exceptionally high impact tests and even grain with the latter.

Properly conducted correspondence, the reading of Papers, and the technical exhibition of samples of these high-grade irons must have a beneficial effect on the industry as a whole.

XUM

The Shipping, Engineering and Machinery Exhibition.

This exhibition, which is being held at Olympia, was opened by Mr. W. C. Bridgeman, the First Lord of the Admiralty, last Monday. It is of dual interest for foundrymen, as at least forty of the exhibitors are foundry owners, which gives one an opportunity of seeing the standard of perfection achieved and features of design on the one hand, and on the other there are several exhibits which are of exclusive interest for foundrymen. For the first time in England, Perlit iron castings are being shown by the British Perlit Iron Company, Limited. The exhibit which appealed to us most was a 3-ft. wedge tapering from about ¼ and about 6 in., and carrying the same grain throughout. In addition, there are numerous samples which demonstrate the properties of Perlit in tension, compression, torsion, under impact, hydraulic pressure, and abrasion. This iron is also shown on the stand of the North-Eastern Marine Engineering Company, Limited.

Another entirely new product being shown is Raffinat, a combination flux and alloy for purifying gun-metal, brass and similar alloys. From what we gathered, it is used when re-melting borings and turnings, the amount used varying with the dirtiness. We believe a copper content of 60 per cent. is guaranteed. It is being sold in Great Britain by the Foundry Chemical Supply Company.

Of furnaces, a Titan cupolette (Constructional Engineering Company) is being shewn by the Norman Engineering Company, electric furnaces of many interesting types by Automatic and Electric Furnaces, Limited, whilst a new system of furnace arching, is shown by Liptak Furnace Arches, Limited.

Welding apparatus is admirably represented, the well-known firms of Allen-Liversidge, Carbic, G. D. Peters, and Quasi-Arc all show working exhibits. We were particularly attracted by a small portable electric welder by the Consolidated Pneumatic Tool Company, which is offered at a price well within the range of even the smallest foundry.

Of foundry requisites, the exhibit of Major Robinson & Company, Limited, gives the opportunity of examining a series of metallic cements. The one for cast iron is shown to be capable of being machined and of taking a thread. This firm also show a pipe-bending machine, which type of tool could usefully be included in the maintenance department of foundries carrying either a large pneumatic or hydraulic plant.

There are a fair sprinkling of engineering stores specialities, such as belting, oils, fats and greases. No less than seven firms show belt fasteners. Probably the W. T. Nicholson & Clipper Company, Limited, are the best known. At all exhibitions where they show they are always appreciated by the other exhibitors because of their kindness in gratuitously adjusting their belt drives.

Foundry raw materials, such as pig-iron, coal, coke, and firebricks of various sorts are shown by the Consett Company.

All technical foundrymen will be interested in the excellent centrifugal castings shown by the Sheepbridge Stokes Centrifugal Castings Company, Limited.

Amongst well-known foundries who are showing their products are Hadfields, Limited (incorrodible material), Thos. Firth & Sons, Limited (Stavbright and other non-corrosive castings), Farrington Steel Foundry (valves, etc.), A. Harper Bean, J. & E. Hall, Fry's Metal Foundry, John Musgrave, Limited, Light Alloy, Limited (Alpax), Vono, Limited, North-Eastern Marine, and E. Green & Son, Limited (economiser castings).

MR. A. J. SIMPSON has been elected president of the Junior Institution of Engineers for the ensuing year, with Mr. R. L. Kirley and Mr. C. E. Atkinson as vice-chairmen, and Mr. C. O. Mourant hon. treasurer. The members of council are The Master of Sempill, Mr. S. Dunlop, Mr. E. D. Gill, and Mr. D. E. Skinner.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Perlit Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

DEAR SIR,—Your correspondent, "A Foundry Manager's," letter, whilst interesting, does not give us much more information on the subject of Perlit iron. What castings has he seen made by the Perlit process which cannot be produced in ordinary cast iron?

Had he attended a joint meeting of the Institution of Mechanical Engineers and Institute of British Foundrymen, Scottish Centre, in the Technical College, Glasgow, last week, he would have found that the meeting ended in the stereotyped manner.

Mr. Young attended that meeting, but, "owing to the lateness of the hour," did not answer any of the many relevant questions put to him by Professor Campion and others, with the exception of admitting that a propeller is not a suitable proposition for the Perlit process. Mr. Young, however, gave a long dissertation on the general "rottenness" of cast iron, and asked his hearers to believe that metal poured into a cold mould became this "rotten" cast iron, but if poured into a hot mould it became an entirely different metal, namely, Perlit.

But, apart from all this, how can Mr. Young make such sensational claims for Perlit iron when he has only been making castings with it "since the Newcastle Races." He has been reading a number of important Papers for the last six months, but what proofs can he give us of the value of Perlit iron regarding wear, or growth, or anything else, from actual performance. German chemists seem to have carried him away with their eloquence, but even they are not conjurers.

I am not surprised to learn that Mr. Young has trouble with test bars, for, as I have already pointed out, stronger bars are produced from a cold mould than from a hot mould.—Yours, etc.,

A FOUNDRY DIRECTOR.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I have followed with interest the correspondence that has appeared in the last few issues of your valuable journal, from "Foundry Director," "Foundry Manager," and the "Perlit Iron Company, Limited,' all more or less dealing with "Perlit Iron," which, as Mr. J. S. Glen Primrose mentioned at the Conference of the Institute of British Foundrymen, in June, at the Glasgow Convention, is an assumed name for iron with a pearlitic structure. This pearlitic structure had been obtained long before the Lanz process was known in this country. I know of two firms who have used the heated mould for over eight years, and the firms in question have controlled the cupola charges to ensure obtaining the pearlitic structure.

The making of these special cast irons, in my opinion, is not so much a matter of additional apparatus in the foundry, but the control of the cupola on sound scientific principles. The "Emmel Thyssen" process for the making of high duty cast iron under the Thyssen patents, which I am given to understand have been applied for in this country and the United States, show that the iron produced gives equal results to that of "Perlit Iron," but at a considerably reduced price. I have been fortunate in recently seeing this "Emmel Thyssen" iron produced at an English foundry, and the ultimate results were really abnormal, giving high tensile test with total carbon under 2.8 per cent., and the fracture of the castings being homogeneous in thin and thick sections.

I should say this new high duty cast iron will go a long way in this country in giving the foundryman something which he has wanted for years, especially as the product produced does not require any special apparatus.—Yours, etc.,

A FOUNDRY METALLURGIST.

MR. M. J. COOPER, a member of the London Branch of the Institute of British Foundrymen, has been appointed foundry manager to The Widnes (1925) Foundry Company, Limited.

Steel Moulding Sands and their Behaviour under High Temperatures.*

By A. L. Curtis (Chatteris, Cambs.), M.I.Brit.F.

(*Continued from page* 426.)

Having obtained a degree of accuracy which gave fairly comparable results on standard test-pieces with the apparatus, the value of P for sample No. 1,970, an artificial steel moulding sand, was determined on eight 25-gr. test-pieces under the same conditions of ramming and mixing, with 5 per cent. water added. The figures obtained are shown in Table III.

As shown by Table III, the value of P = permeability is considerably lower for sample 1,970 than it was for the 40 × 50 silica sand, plus 20 per cent. ball clay, with 5 per cent. water added in each case. If, however, the crop of sample 1,970 (Fig. 2) is referred to, it will be seen that a large percentage of the sand grains of this

TABLE III.—*Permeability Tests on 25 grms. No. 1,970 artificial steel moulding sand: mixed 200 times wet.*

Test-Piece No.	Pressure on Manometer.	P=Permeability.
	Grms.	
1	15.5	59.2
2	16.1	57.9
3	15.8	59.0
4	14.5	65.1
5	14.5	64.5
6	13.9	68.8
7	14.5	65.1
8	14.8	63.0

Average for P = 62.8. Highest error, 9.5 per cent.; lowest error, 7.8 per cent.

sample are smaller than a 50-mesh sieve, some of which would clog the pore space of the larger grains and account for the lower permeability.

Crushing tests made on the first three air-dried test-pieces of sample 1,970 showed an average crushing strength of 26.5 lbs. per cub. in.

The crushing strength of sample No. 1,970 was rather higher than that of the standard 40 × 50 silica sand, probably due to its more dense structure, borne out by the permeability figures.

U.S.A. greensand facing mixture No. 4 (Sivyer Steel Castings Company) was next tested for permeability and compression strength. Eight test-pieces of 25 grs. each were used (Table IV.).

TABLE IV.—*Permeability Tests on 25 grms. U.S.A. greensand facing mixture No. 4.*

Test-Piece No.	Pressure on Manometer.	P=Permeability.
	Grms.	
1	9.5	110.0
2	8.8	119.0
3	9.5	110.0
4	9.5	113.75
5	10.5	94.5
6	9.4	113.5
7	11.5	82.5
8	10.5	95.2

Average for P=104.8. Highest error, 13.5 per cent.; lowest error, 21.1 per cent.

Compression tests made on the above test-pieces, Nos. 3 to 8 inclusive, gave an average crushing strength of 26.78 lbs. per cub. in.

It will be seen that although there is little difference between the crushing strengths of the American greensand facing mixture No. 4 and English artificial steel moulding sand No. 1,970, yet a wide difference occurs in permeability, U.S.A. No. 4 showing P = 104.8 and English sand No. 1,970 P = 62.8. This difference of 42 in the value of P might be accounted for by taking into consideration the spherical shape of the grains of the American silica sand used in the mixture, compared with sub-angular grains of the English Lower Greensands, which would make the U.S.A. facing sand mixture far more permeable to gas without necessarily sacrificing strength.

In order to see if there were any great physical difference between U.S.A. heap or old sand No. 3 (the assumed waste product of U.S.A. facing mixture No. 4) and No. 4 greensand facing mixture, similar tests were made on the old sand. Table V given below show results obtained.

TABLE V.—*Permeability Tests on 25 grms. No. 3 U.S.A., heap sand: water, 1.25 c.c. = 5 per cent.: mixed 200 times wet: rammed, 50 lbs. per square inch: air passed, 1,000 c.c.*

Test-Piece No.	Pressure on Manometer.	P=Permeability.
	Grms.	
1	11.5	85.9
2	11.4	86.6
3	7.9	132.5
4	9.0	112.75
5	8.0	126.75
6	10.4	97.7
7	11.1	90.0
8	11.5	83.6

As seen from the figures, little difference occurs in the value for P between U.S.A. heap sand No. 3 and U.S.A. greensand facing mixture No. 4, and a comparison of their size diagrams (Figs. 16 and 7*a*) shows them to possess a similar grain size. On testing the crushing strength of U.S.A. heap sand No. 3, the old sand was generally weaker than the facing mixture.

It was found that old sand No. 3 is slightly weaker than facing mixture No. 4, and therefore crushes at a less pressure, the average being that P = 104.8 and 101.9 for the U.S.A. No. 4 facing sand and the U.S.A. No. 3 old sand respectively. The crushing strength figures were 26.78 and 23.36 lbs. per cub. in. respectively.

In order to determine and compare the relative values of permeability and crushing strengths for steel facing sand mixtures used in current practice, samples were selected from facing sands in use in ten steel foundries situated in different parts of England. Table VI shows the results of these tests.

TABLE VI.—*Permeability and Crushing Strengths. Steel Facing Sand Mixtures in use in English Steel Foundries.*

Sample No.	P = Permeability.	Crushing strength in lbs. per cubic inch.		Water.	Remarks.
		Wet.	Dry		
				Per cent.	
95	93.4	7.65	30.63	5.0	Coarse face. Damp.
1565	63.0	10.72	30.36	5.0	Close face. Correct water content.
1419	43.7	14.21	65.54	6.0	Close face.
1965	29.5	7.54	28.48	5.0	Very close face. Dry.
1971	57.55	11.58	30.00	5.0	Good face.
1265A	103.1	13.14	39.43	4.5	,, ,,
1970	62.8	8.93	26.50	5.0	,, ,,
1100	66.3	16.55	49.40	5.0	,, ,,
1970A	75.05	10.22	23.11	5.0	Close face.
1530	134.6	8.40	31.64	5.0	Coarse face. Damp.

It will be seen from the above figures that these steel facing sand mixtures had a value for P = permeability varying between 29.5 and 134.6, a very large margin of difference, possibly responsible for some of the troubles occurring in the steel foundry. It is obviously impossible in a memoir of this character to give details of the steel foundries using the above facing mixtures, but the inference might be drawn that steel facing

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* Carnegie Scholarship Memoir (Iron and Steel Institute).

sand mixtures with a lower permeability than 50, or a higher value for P than 100, could be greatly improved upon.

Certain of these steel facing sand mixtures were analysed and gave results shown in Table VII:—

It would appear that certain old sands become more broken up and dehydrated during use than others, so that they finally bear little relationship to the original steel facing mixtures. This would probably account for the great variation in figures shown above, and the little apparent relationship between the figures for permeability, crushing strength, and analysis of the steel facing sands and the used sands derived therefrom.

TABLE VII.—*Composition of Samples Used in Table VI.*

Sample No.	95.	1565.	1419.	1965.	1971.	1970.	1100.
SiO_2	93.12	91.74	87.54	92.40	90.12	91.92	88.52
Al_2O_3	2.86	3.72	6.19	2.44	5.24	4.29	4.92
Fe_2O_3	1.28	1.28	2.14	2.28	1.14	1.43	2.86
CaO	0.20	0.20	0.22	0.10	0.20	0.10	0.12
MgO	0.16	0.21	0.19	0.09	0.12	0.06	0.07
K_2O	0.19	0.85	0.63	0.19	0.26	0.15	0.34
Na_2O	0.03	0.41	0.26	0.12	0.27	0.05	0.19
TiO_2	0.70	0.38	0.29	0.28	0.32	0.20	0.30
Loss on ignition ..	1.70	1.50	2.65	2.28	2.35	1.96	3.00
	100.24	100.29	100.11	100.18	100.02	100.16	100.32

When comparing the analyses given above with the permeability figures and crushing strengths, it is curious to note that sample 1419 took 65.54 lbs. per cub. in. to crush, whereas sample 1100, the next strongest test-piece, broke at 49.40 lbs. per cub. in., both these samples being considerably stronger than the other steel facing sand mixtures. The contributing factors in sample 1419 which could be associated with this strength are apparently the high alumina and loss on ignition, which are 6.19 per cent. and 2.65 per cent. respectively. Sample 1100 also shows high figures for alumina and loss on ignition, viz., 4.92 per cent. and 3.00 per cent. On the other hand, sample No. 1971, with 5.24 per cent. alumina and 2.35 per cent. loss on ignition, only showed a crushing strength of 30.00 lbs. per cub. in., so it does not necessarily follow that the high figures for alumina and loss are entirely responsible for strength. The strength of an air-dried sand is therefore probably more a question of its physical state than its chemical composition. On comparing the permeability of these facing mixtures with the figures obtained on analysis, there does not appear to be any definite relationship between the value for P and the figures given for the different elements.

In order to compare the permeabilities and crushing strengths of used sands derived from certain of the steel facing sand mixtures dealt with, tests were made on the old or floor sands sampled from steelworks in which the following mixtures were in use, viz.:—

	P = Permeability.	Crushing strength. Lbs. per cub. in.
Steel facing sand No. 95 ..	93.4	30.63
Old sand, No. 96 ..	95.5	34.45
Steel facing sand, No. 1565	63.0	30.36
Old sand, No. 1566 ..	33.1	33.68
Steel facing sand, No. 1971	57.55	30.00
Old sand, No. 1840 ..	99.7	28.61
Steel facing sand, No. 1419	43.7	65.54
Old sand, No. 1417 ..	92.2	30.68
Steel facing sand, No. 1970	62.8	26.50
Old sand, No. 1350 ..	67.1	17.79

On analysis, these old sands gave the figures shown in Table VIII:—

TABLE VIII.

Sample No.	96	1566	1840	1417	1350
SiO_2	90.48	87.52	90.56	87.44	90.00
Al_2O_3	2.57	5.39	4.55	6.35	5.57
Fe_2O_3	2.28	2.57	2.71	1.43	2.28
CaO	0.40	0.40	0.16	0.36	0.32
MgO	0.23	0.39	0.26	0.34	0.36
K_2O	1.28	0.81	0.23	1.47	0.22
Na_2O	0.96	0.54	0.05	1.24	trace
TiO_2	0.35	0.40	0.30	0.26	0.27
Loss on ignition	1.65	1.88	1.18	1.38	1.12
	100.20	99.90	100.00	100.27	100.14

The term "permeability" here applies only to those parts of a mould which are exposed to ferrostatic pressure, as it must not be supposed that a closed mould ready for casting is impermeable to air. To test the point a mould was made up for casting a 1-in. cube, using two boxes, air being fed through a pipe led into the upper box, which was firmly embedded on to a bottom box, which again was firmly embedded in the sand. On passing air connected with a manometer through the closed mould no pressure could be recorded, as the air leaked out through the joints of the mould and through the sand itself. This problem has been carefully investigated by E. Ronceray, of Paris, on shell moulds, who arrived at the same conclusion.

As one of the primary objects of this Paper was to prove variation in character of natural argillaceous sands used for making steel facing sand mixtures, the series of samples taken from the Pliocene deposit of St. Erth, Cornwall, quarried between 1913-23, were tested for permeability and crushing strengths. It was thought advisable to test a complete series of samples from a well-known argillaceous sand deposit of Pliocene origin rather than a number of samples from different sources which might not be truly representative, even if their origin were undoubted.

For this purpose the following samples of Cornish sands were tested:—

Sample Nos.		
1301–2–3–4	Sampled in	1913
,, 1305	,, ,,	1914
,, 1319	,, ,,	1915
,, 1306–7–9–10–11–12–13–14–15–20–21	,, ,,	1921
,, 1322–23	,, ,,	1922
,, 1324	,, ,,	1923

Some of the permeability tests were made on the above sands in their natural state, but when subsequent investigations showed that a 25-cm. manometer was too small to register the air pressures, it was decided to test the whole series of samples after mixing with an equal weight of 40 × 50 standard silica sand. This course was adopted for two reasons. First, because a very strong argillaceous sand required far more water to make it cohesive than is usual in steel foundry practice. Secondly, strong sands of this character would be useless as steel-moulding sands in their natural state. The idea, therefore, of mixing all the samples with equal weights of a standard silica sand was to bring them into the range of prospective steel facing sand mixtures.

In certain cases this procedure had its disadvantages, because when mixing equal parts of standard silica sand with the weak varieties of St. Erth sand, strength was sacrificed. In order to get figures for P = permeability from the weaker Cornish samples, these were tested in their natural state.

As previously mentioned, sample No. 1301, St. Erth sand, when used neat successfully produced castings in steelworks No. 1. This sand can

therefore be assumed to possess the correct clay substance and mechanical strength for use as a steel facing sand mixture, and its coefficient of permeability a useful guide as to what a steel facing sand should be.

Before deciding on the water content necessary to produce maximum cohesiveness consistent with practical use, several tests for permeability were made with varying percentages of water, as is shown in Table IX:—

TABLE IX.—*Permeability Tests on 25 grms., No. 1301, St. Erth argillaceous sand, with varying water contents.*

Water.	Pressure on Manometer.	P = Permeability.	Remarks.
Per cent	Grms.		
5	19.1	48.95	Too dry.
6	15.6	67.1	Correct water.
7	16.2	62.2	Rather too much water
8	15.6	65.3	Too much water.
9	16.6	58.2	Wet.
10	18.6	47.7	Very wet.

The same test-piece was used throughout, but remixed with extra water before each successive test.

From the above figures it will be seen that the water contents between 6 and 9 per cent. had little effect on the value for P. On the other hand, any water added in excess of 6 per cent. made the sand too wet for use as steel facing sand. Maximum cohesiveness was obtained with 6 per cent. water, which amount was adhered to when testing the further eight test-pieces, the results being given in Table X:—

TABLE X.—*Permeability Tests on 25 grms. St. Erth argillaceous sand, No. 1301.*

Test-Piece No.	Pressure on Manometer.	P = Permeability.
	Grms.	
1	15.6	67.1
2	18.6	43.4
3	15.5	64.2
4	16.5	59.6
5	14.8	70.8
6	15.3	68.4
7	16.5	61.8
8	16.5	61.7

It will be seen that sand No. 1301 had a permeability figure P = 62.8, which closely resembles that of sample No. 1970. Judging from permeability figures alone, it might be assumed there was a relationship between the grain-size of these two samples. On referring to the size diagrams (Figs. 2 and 3) it will be noticed that a great difference occurs in the grain-size of the two sands, sample No. 1970 being considerably larger in grain-size than 1301. It is curious, however, that these sands, one a natural variety, the other an artificial steel facing mixture, both having reputations for producing sound, clean steel castings, and possessing similar values for P, should have grain-sizes so vastly different. In addition to the permeability figures, the silt and clay substance contents of the two sands, excluding loss, agree closely.

In order to prove if any relationship existed between the average grain-size of a steel facing sand mixture and its permeability, it was decided to calculate the average grain-size of samples 1301 and 1970, using a method suggested by Professor Shearer, of Cornell University, Ithaca, New York, U.S.A., and adopted by Professor Heinrich Ries.[1]

The percentage of grains given on each sieve was obtained from the washed residues given in earlier parts of this paper, all losses being neglected. The size of the grains retained on each sieve was taken from the sieve apertures given by Messrs. J. & F. Pool, Limited, makers of the sieves, between 10 and 200 mesh, which were used throughout the experiments. Assuming that sand grains retained on one sieve passed the previous sized sieve, the aperture of the latter was taken to be the size of those grains. The average size of the silt and clay substance was assumed to be 0.004 in., since it all passed through a 200-mesh sieve, of aperture 0.004 in.

On working out the average grain-size for samples 1970 and 1301, it was found that sample 1970 had a larger average grain-size than No. 1301, viz., 0.01311 in. compared with 0.00811 in. It will therefore be seen that although the samples had similar values for P = permeability, there is apparently no relationship between their average grain-sizes; thus showing it is practically impossible to calculate the average size of a sand and assess a value for P from the figures thus obtained.

Cornish sand No. 1302, sampled in the same year as 1301 (1913), was next tested, which gave similar figures for P, as is shown in Table XI.

TABLE XI.—*Permeability Tests on 25 grms., No. 1302, St. Erth argillaceous sand.*

Test-Piece No.	Pressure on Manometer.	P = Permeability.
	Grms.	
1	15.5	62.7
2	15.5	65.8
3	16.6	59.1
4	15.5	67.5
5	15.7	64.85
6	17.1	56.5

On comparing the permeabilities as shown by the value for P of samples 1301 and 1302, the results for P, namely, 62.1 and 62.74, are almost identical. On referring to the size diagrams (Figs. 3 and 4), it will be seen that the grain-size of the two sands is very similar. These comparisons, besides checking the accuracy of the tests carried out, show that St. Erth sand was very stable in size in 1913.

Only sufficient sand from sample 1303 was left to make two permeability tests, which gave 48.15 and 52.5 respectively.

It will be seen that the value for P of sample 1303 was only 50.32, being considerably lower than samples 1301 and 1302. It is difficult to account for this drop in permeability when comparing the size diagrams of the three sands, the only explanation being that the grain-size of 1303 is smaller on the whole than 1301 or 1302, which would account for the lower permeability.

The amount of sample 1304 left was insufficient to make a test, which was unfortunate, as the grain-size of 1304, shown on the size diagram (Fig. 6), was rather unique. Part of the sample, however, was mixed with 12.5 grammes of No. 1302, in order to make a 25-gramme test-piece. This gave a permeability of 49.8. Probably a much lower value for P would have been obtained had it been tested in its original state, as the bulk of the grains in 1304 sample, when washed, lay between 90 and 110-mesh sieves. In an earlier part of the paper attention was called to the fact that sample 1304 gave unsatisfactory results in steelworks No. 4.

St. Erth sand No. 1305, sampled in 1914, was next tested, the results being shown in Table XII.

TABLE XII.—*Permeability Tests on 25 grms. St. Erth argillaceous sand, No. 1305, sampled in 1914; mixed with 6 per cent. water.*

Test-Piece No.	Pressure on Manometer.	P = Permeability.
	Grms.	
1	17.3	56.7
2	17.3	58.1
3	16.5	60.4
4	17.7	53.3
5	17.7	54.6
6	18.5	49.1
7	18.1	50.2
8	17.5	55.25

The figures show that this sand is somewhat less permeable than samples 1301 and 1302. As in sample 1303, the small grains of 1305 are apparently responsible for the drop in the value for P = permeability.

Cornish No. 1319, sampled in 1915, was then tested. On commencing the test with 6 per cent. water, this amount was found to be too small,

[1] "The Foundry," No. 5, 1906, Vol. XXVII, page 331.

so 7 per cent. was used on the following test-pieces, results being given in Table XIII.

TABLE XIII.—*Permeability Tests on 25 grms. St. Erth Cornish sand No. 1319, sampled 1915.*

Test-Piece No.	Pressure on Mano-meter.	Time.	Height of Test-Piece.	P=Per-meability.
	Grms.	Secs.	Cm.	
1	23.7	51.0	3.5	33.75
2	23.7	52.5	3.5	33.07
3	22.6	49.0	3.5	36.84
4	23.9	50.0	3.45	33.65
5	23.7	51.0	3.45	33.27
6	22.5	49.5	3.45	36.10
7	22.5	49.0	3.5	37.00
8	23.7	51.5	3.4	32.47

Except No. 1 (6 per cent.) all were mixed with 7 per cent. water.

As seen from the table the permeability of sample 1319 is very low compared with samples 1301, 1302, 1303 and 1305. Its size diagram showed than an abnormal amount of residues were retained in 130- and 140-mesh sieves. In order to see whether these residues, amounting to 8.250 per cent. and 11.314 per cent. respectively, were responsible for lowering the permeability of the sand, all the washed residues of the sample minus the above were mixed together 200 times, and 25 grammes weighed out for test. Results showed that only a slight increase in permeability occurred, from P=34.52 to P=36.5.

In view of this abnormally low permeability, it was decided to work out the average grain-size, and to prepare a facing sand mixture of equal average grain-size to that of U.S.A. No. 4, by adding to sample 1319 an amount of 40 × 50 standard silica sand, in order to ascertain if the permeability of the resultant mixture equalled that of U.S.A. No. 4.

As all grains in the 40 × 50 standard silica sand used passed a 40-mesh sieve and were retained on a 50-mesh sieve, its average grain-size was assumed to be equivalent to sieve 45, the average grain-size then being $\frac{1}{45}$, or 0.02222 in.

The average grain-sizes of samples 1319 (0.00599) and U.S.A. No. 4 (0.01345) were then determined by the method used for 1970 and 1301 samples.

A mixture was then made up of 40 × 50 standard silica sand and sample 1319, based on the average grain-sizes of the two sands, viz.: 40×50 silica sand, average grain-size=0.02222 in., and sample No. 1319, average grain-size = 0.00599.

By calculation it was found that to obtain a mixture having an average grain-size of 0.01344 in., comparable with No. 4 U.S.A. facing sand, whose average grain-size was 0.01345 in., the following proportions were necessary: 40 × 50 silica sand, 46 per cent., and sample No. 1319, Cornish sand, 54 per cent.

If any relationship exists between permeability and average grain-size, such a mixture should give a value for P = permeability almost identical with that of U.S.A. No. 4 facing mixture, or P = 104.8. On testing the mixture it was found that a great difference occurred in the values for P:—

Mixture of average grain-size, 0.01344 in., permeability = 65.83.

U.S.A. No. 4 facing sand, of average grain-size, 0.01345 in., permeability = 104.8.

These figures again go to prove that no relationship exists between average grain-size and permeability, as it is possible for two different sands possessing the same average grain-size to have totally different permeabilities.

Cornish sands Nos. 1314, 1309, and 1312, sampled in 1921, from the weak group, were then tested, and the results were that they gave average figures of 61.5, 51.2 and 49.8 respectively.

Judging from permeabilities it will be seen that sample 1314 closely resembles samples 1301 and 1302, whereas samples 1309 and 1312 are more like sample 1303. This is confirmed on the size diagrams shown in earlier parts of the Paper (Figs. 3, 4, 5).

The Cornish sands from the strong group, sampled in 1921, Nos. 1307, 1315, 1313, 1311, and 1310 were then dealt with. Water was added to No. 1307, commencing with 6 per cent., and additions of 1 per cent. were made until 12 per cent. was reached. The sand with this water content was still too dry. When put into the container and tested, water was blown out of a 25-cm. manometer, so no results could be obtained. As the sand was much too strong for use in its natural state as a moulding sand, a number of mixtures were made up to break down its strength and increase permeability.

The following figures (Table XV) show the differences brought about in permeabilities by adding these varying amounts of silica sand to sample 1307.

TABLE XV.—*Permeability Tests on St. Erth argillaceous sand No. 1307, sampled 1921, when mixed with increasing proportions of 40×50 standard silica sand: 25 grm. test-pieces: mixed 100 times dry: mixed 200 times wet: rammed 50 lbs. per square inch: air passed, 1,000 c.c.*

Ratio	Pressure on Mano-meter.	P = Perme-ability.	Remarks.
	Grms.		Per cent.
1 to 1	16.3	55.1	Water, 5. Very dry.
1.5 ,, 1	9.8	105.3	,, 4. Too dry.
2 ,, 1	8.2	159.0	,, 4. Too strong
2.5 ,, 1	6.2	177.0	,, 4. Good sand
3 ,, 1	5.4	209.5	,, 4. Rather wet
3.5 ,, 1	4.8	239.5	,, 4. Too wet.

As the remaining samples of the strong group were also too strong to be tested alone for permeability, they were similarly mixed with varying proportions of 40 × 50 silica sand, in ratios of 1 to 1, 1.5 to 1, 2 to 1, and 2.5 to 1, the results being shown in Table XVI:—

TABLE XVI.—*Permeability Tests. St. Erth argillaceous sands, strong group, sampled in 1921, when mixed with increasing proportions of 40×50 standard silica sand; 25-grm. test-pieces; mixed 100 times dry; mixed 200 times wet; rammed 50 lbs. per square inch; air passed, 1000 c.c.*

Sam-ple No.	Ratio.	Pressure on Mano-meter.	P= Perme-ability.	Remarks.
		Grms.		Per cent.
1315	1 to 1	9.8	109.4	Water 5. Too strong.
	1.5 ,, 1	7.4	146.3	,, 4. Good sand.
	2 ,, 1	6.0	191.4	,, 4. Rather wet.
	2.5 ,, 1	5.2	231.2	,, 4. Wet and weak.
1313	1 to 1	12.7	77.1	Water 5.5. Too strong
	1.5 ,, 1	8.1	127.9	,, 4.8. Good sand
	2 ,, 1	6.5	176.6	,, 4. Good sand.
	2.5 ,, 1	5.4	206.3	,, 4. Wet and weak.
1311	1 to 1	10.3	97.9	Water, 5. Too strong.
	1.5 ,, 1	7.5	148.6	,, 4. Good sand.
	2 ,, 1	6.9	169.0	,, 4. Good sand.
	2.5 ,, 1	5.5	218.6	,, 4. Wet and weak.
1310	1 to 1	10.8	95.8	Water, 5. Too strong.
	1.5 ,, 1	7.1	154.5	,, 4. Good sand.
	2 ,, 1	6.3	182.2	,, 4. Weak and wet.
	2.5 ,, 1	5.8	207.1	,, 4. Weak and wet.

It will be seen that sample No. 1307 is the strongest sand in the strong group, with a permeability of only 55.1 when mixed with 50 per cent. of 40 × 50 standard silica sand. This sand also requires at least twice its weight of silica sand mixed with it to bring it into the range of useful steel facing sand mixtures. Apparently there is not much variation in permeability between the other samples of this group, and reference to the silt and clay substance contents, as shown on the size diagrams in earlier parts of the Paper, would seem to confirm this. Even these sands require approximately 1.5 times their weight of silica sand to give any resultant mixture a good value for P. The above figures record a still further instance of the great variation in character of argillaceous sands of Pliocene origin.

On testing sample 1306, the strongest sample of argillaceous sand the author was able to find at St. Erth pits, it proved even stronger than sample 1307. This sand had also to be mixed with 40 × 50 silica sand in proportions 1 to 1, 1.5 to 1, 2 to 1, and 2.5 to 1, in order to get readings on the 25-cm. manometer.

TABLE VII.—*Permeability Tests. St. Erth argillaceous sand, No.* 1306, *sampled* 1921, *when mixed with increasing proportions of* 40×50 *standard silica sand: 25 grm. test-pieces: mixed* 100 *times dry: mixed* 200 *times wet: rammed, 50 lbs. per square inch: air passed,* 1000 *c.c.*

Ratio.	Pressure on Manometre.	P= Permeability.	Remarks.
	Grms.		Per cent.
1 to 1	23.9	31.9	Water, 5. Too dry.
1 ,, 1	23.6	29.6	,, 9. Too strong.
1.5 ,, 1	15.8	59.8	,, 4. Too dry.
1.5 ,, 1	22.3	30.25	,, 9. Too strong.
2 ,, 1	10.3	102.0	,, 4. Too dry, too strong.
2.5 ,, 1	7.1	154.5	,, 4. Too dry.
2.5 ,, 1	7.1	154.5	,, 5.5. Good mixture.

A large number of Cornish sands from St. Erth pits, sampled between the years 1913 and 1923, were then tested in order to compare the variation in permeability of this argillaceous sand. Each sample was mixed with an equal weight of 40 × 50 standard silica sand, in order that all samples might be tested under the same conditions. In addition, crushing tests were made on each of the test-pieces after air drying, with a view of seeing whether any relationship existed between permeability and crushing strength. The figures obtained varied from 31.9 for sample No. 1306 to 157.8 for sample No. 1322. The crushing strengths varied inversely from 90.32 to 23.09 lbs. per cub. in. respectively.

In order to see how the permeable qualities of Cornish sands compared with similar types of Belgian argillaceous sands, tests were carried out on samples of the best varieties of Belgian red and yellow sands. The results of the tests show that the values for P varied between 72.29 and 297.5.

It will be seen that as a general rule Belgian argillaceous sands are not as strong as the strong Cornish varieties, which means that the latter would prove more economical as a base for producing greensand steel facing mixtures. On the other hand, the Belgian red sands possess a coarse grain-size exceedingly useful for building up a greensand facing mixture. The analyses of these sands were as follows:—

No. 1265—SiO_2, 93.08; Al_2O_3, 2.94; Fe_2O_3, 1.71; CaO, 0.28; MgO, 0.21; K_2O, 0.36; Na_2O, 0.12; TiO_2, 0.07; loss on ignition, 1.18 = 99.95 per cent., and No. 1270—SiO_2, 89.40; Al_2O_3, 5.63; Fe_2O_3, 2.57; CaO, 0.10; MgO, 0.10; K_2O, 0.15; Na_2O, 0.04; TiO_2, 0.40; loss on ignition, 1.74 = 100.13 per cent.

SUMMARY.

It has been proved that very great variation occurs in natural argillaceous sands of Pliocene origin, of which the St. Erth variety may be taken as well representative, and that similar variation occurs in steel facing mixtures in current practice. It is therefore safe to assume that much more frequent control tests are necessary before either choosing supplies of raw sands or preparing facing mixtures in the steel foundry.

Having shown that variation in quality of natural sands can be more quickly proved by refractory and washing tests than by chemical analysis, control tests could be rapidly made by these methods, whilst permeability and crushing (dry) tests on the lines described afford a sufficient indication of the physical qualities of any resultant facing mixture.

The author realises that the factor of mechanical green strength has an important bearing on steel facing mixtures, but lack of time has prevented this condition being investigated in time for incorporating any data in this memoir.

Manufacture of Brasses with Nickel and Manganese.*

By MONS. LE THOMAS, of the Naval Engineers.

This Paper was extremely interesting in view of the nature of the metal dealt with, and especially for its description of the manner in which any alloy might be practically examined.

The alloy in question was a special brass, which should show the following characteristics:—Tensile strength, 28 tons per sq. in.; elongation, 25 per cent.; and yield point, 12.7 tons per sq. in.

These brasses combined the strength of steel with the non-corrosiveness of bronze (in bronze with 10 per cent. of Sn the tensile strength was only equal to 12.7 to 15.8 tons per sq. in., and the elongation 12 to 16 per cent.). They were easily forged and cheaper than bronze. In short, they were brasses of 60/40 with certain additions. The percentages should range from 62/38 to 56/44.

The additions were then considered. Brasses made with the addition of aluminium should be treated with the utmost care during the entire course of the work, since aluminium had a high coefficient of equivalence (6). Manganese, having a much lower coefficient of equivalence (0.5), could be introduced much more readily, and was, therefore, very largely employed. Tin was used only in special cases (condensers); Laveyssière metal was a 60/40 brass with 1 per cent. Sn. Lead was injurious if in excess of 0.08 per cent.; cadmium likewise; magnesium and antimony if exceeding 0.2 per cent.; phosphorus in any proportion; and iron if exceeding 1.7 per cent. Silicon had a complex action, but the proportion must always be slight. Nickel had a negative coefficient of equivalence, and, consequently, increased the arbitrary standard of copper content; a sufficient proportion was favourable as regards mechanical properties.

On these bases the author first produced two test alloys, each containing 3.5 per cent. of Ni and 4 per cent. of Mn, with arbitrary standards of 56/44 and 62/38 respectively. It was found that their mechanical and melting properties were much superior to bronze, and that no appreciable oxidation took place. A most careful handling was, however, necessary.

He then gave a whole series of compositions, differing from but analogous to the foregoing, as well as the results of the cold and hot (225 deg.) mechanical tests and the corresponding micrographs. These showed that the best mixture was 5 per cent. Ni, 3 per cent. Mn, and an arbitrary standard of 59/41, an alloy which gives:—

In the As-Cast State.—Cold (15 deg.): Tensile strength, 29.8 tons per sq. in.; elongation, 27 per cent.; and a yield point of 14.6 tons per sq. in. *Hot* (225 deg.): Tensile strength, 27.9 tons per sq. in.; elongation, 29 per cent.; and a yield point of 14 tons per sq. in.

In the Worked State.—Cold (15 deg.): Tensile strength, 31.7 tons per sq. in.; elongation, 27 per cent; and yield point, 24.7 tons per sq. in. *Hot* (225 deg.): Tensile strength, 28 tons per sq. in.; elongation, 26 per cent.; and yield point, 22.2 tons per sq. in. These figures were very much higher than those required by the French Navy.

Although it contained nickel, the prime cost of this metal was only about frs. 660 (say £6), as compared with frs. 983 (say £9) for bronze (per 100 kg., or 2 cwt.). Its specific gravity was approximately 8.3. The alloy could be easily worked and tinned. It could not be corroded by sea water.

Its manufacture was simple. The mixture of cupro-Mn and cupro-Ni was first melted under borax or sea salt; the brass was then added, partly in the form of scrap, and partly as an alloy of the standard 55/45. After complete fusion the amount of zinc required for the exact standard was added; the temperature of the whole was then measured, casting being effected at 950 deg. Success depended solely upon the careful calculation of the charges and the measurement of the temperature.

MR. M. J. COOPER has been appointed manager over the foundries of the Widnes Foundry Company (1925), Limited.

* Extract of a Paper presented to the Liege Franco-Belgian Congress.

History of Lock-Making.

From the very earliest days man has been compelled to exercise his ingenuity in devising means of preserving the sanctity of his dwelling against unwelcome intruders.

The primitive cave man rolled rocks or boulders into the mouth of his cavern to keep out his enemies.

The substitution of the "house" for the "cave" by no means lessened the need for measures of safety. All that it did was to render variations of method and new devices necessary. It is an extraordinary thing, but man has always been the worst enemy of man, and even when the impulses of civilisation began to stir the world man was still under the obligation of fastening his doors by wooden bars in order to protect his household goods and chattels.

The early Egyptians were the first to turn their attention to the art of lock-making. Four thousand years ago their inventive genius was grappling with the problem of producing a lock which could be opened only by means of a proper key.

The design of a lock was found depicted among the bas-reliefs which decorated the great temple at Karnak.

Rude in construction, the first locks were made of wood. The upper part of the case which was attached to the door contained three opening, or slots, in each of which was fixed a pin with a head to prevent it from falling too far down. When the bolt was pushed home the pins fell into three corresponding holes on the bolt, and so prevented it from being withdrawn.

At one end of the key, which was also made of wood, were three pins, and when the key was pushed into an opening, left for the purpose in the bolt, these pins lifted up the three pins in the lock case and thus liberated the bolt.

Locks of this type are still in use in Turkey and some of the Eastern countries. The Chinese used wooden locks with tumblers, while the Pompeiians constructed locks of bronze and iron.

The skilled artificers of Germany in the fifteenth, sixteenth and seventeenth centuries devoted considerable attention to lock-making. Their productions were elaborately adorned with hammered ironwork, and this fact, combined with their complicated construction, rendered them too costly for general use.

For two centuries or more ordinary every-day requirements were met by a simple type of spring lock. Later came the tumbler lock, which in 1778 was largely superseded by a device patented by Barron. This was a development of the principle of the tumbler. The first lever lock made its appearance in 1780, and was the invention of one Moses Bird.

A totally different line was struck by Joseph Bramah in 1788, a man of singularly fertile brain, whose inventive resourcefulness and versatility, according to some critics, rivalled those of the elder Brunel. He constructed a lock on a new principle. Its chief distinguishing feature was an inner barrel turning inside a fixed cylinder. The key was a pipe with slits and a pin. Bramah was the originator of the modern padlock, and in this connection an incident of the Great Exhibition of 1851, which produced a somewhat stormy controversy, may be recalled. It arose out of the issue of a challenge to pick, without injury to the lock, a Bramah padlock, which had been an object of public interest through being exhibited in a shop window for years. A prize of two hundred guineas was offered to the successful "picker," and it was won by an American named Hobbs. The task occupied him a little over sixteen days, and though objections were raised they were overruled, and it was conceded that Hobbs was fairly entitled to the award.

Further notable developments in lock-making were achieved by Chubbs in 1818, and Lord Grimthorpe was responsible for the invention of an important modification of the tumbler lock. In 1831 Mr. Rutherford, of Jedburgh, Scotland, produced a time lock embodying the principle of a combination of a lock with a watch. This was so devised that when set the lock could only be opened at a particular hour, even by the owner. This was improved upon by Mr. Yale, of Philadelphia.

Mr. Hobbs introduced changeable keylocks into England for the first time, and the Dutch are credited with the origination of the letter lock, a contrivance which has to be opened in such a way as to enable a set of revolving rings, on which are engraved the letters of the alphabet, to spell some prearranged word of four or more letters.

Nowadays, locks of almost every conceivable kind are made for a wide range of purposes, and English products are known and esteemed alike for their workmanship and general reliability the world over.

The chief centre of the industry is Willenhall, popularly known as "The Town of Locks and Keys," though lock-makers made their appearance in Bilston as far back as 1590. In 1770 Willenhall contained 148 locksmiths, Wolverhampton 134, and Bilston 8, but in 1855 the figures were Willenhall 340, Wolverhampton 110, and Bilston 2.

Until comparatively recent times lock-making was carried on for the most part in small domiciliary workshops, and romantic as were the origins of the craft, there was precious little romance about these dingy buildings. Low-roofed, ill-ventilated, sometimes badly lighted, at all times teeming with dirt and dust, they were more like the fantastic creations of disordered fancy than actual human workshops. The nearest parallel that can be suggested is to be found in the wretched buildings in which at one period the workers in the nail and chain trades eked out their livelihood.

The rise of the factory effected a great and urgently needed improvement in the conditions of the working locksmiths. If it did not make for increased pay, it at least ensured for them healthier and more wholesome environments.

In the old days locks were produced by laborious hand processes. The various parts were forged and hammered out to suit requirements while the "wards" of keys were cut out separately. The outer plates of the best qualities of mortice locks were invariably polished by means of files, and some of the makers were wonderfully adept in producing different varieties of criss-cross markings.

Under existing conditions mass production prevails, and the principal parts of the cheaper kinds of locks are either stamped or cast. It is probably the vastly increased productive capacity of the trade that inspired the legend that if a Willenhall locksmith happened to drop a lock he was making he never stooped to pick it up, because he could make another in less time.

Generally speaking, mass production is considered to be destructive of individual initiative and enterprise. But opportunities for inventions and improvements are still to be found even in the lock trade, and from time to time workmen display their ingenuity by surprisingly skilful productions. Manufacturers are quick to encourage the original craftsman, and every facility is offered for the invention of novelties.

Bramah's great padlock has been outrivalled alike as regards size and complexity by the productions of modern workmen. The big lock is, however, probably easier to make than the miniature. A Willenhall workman of 63 is credited with having made a padlock which, together with its key, was not the weight of a silver twopenny-piece.

Keys are invariably made apart from the locks, constituting a separate branch of the trade. In this direction, too, wonderful skill and ingenuity have been exercised, and some of the keys made for presentation purposes have been worthy to rank among the finest products of industrial art.

We are living in days of advanced civilisation, but we are apparently no nearer than the original cave men to the ideal of universal trustfulness, and the man who wishes to keep his house reasonably secure still has to have recourse to the locksmith.

T. B. F.

To Fix Brass Letters on Glass.—Mix together 15 parts of copal varnish, 5 parts of drying oil, 2 parts of turpentine, 5 parts of marine glue (in liquid form), and melt in a water bath. Add to this about 10 parts of dry slacked lime. This mixture is unfailing in its desired object.

The Production of Diesel Castings in Pearlitic Cast Iron.*

By A. J. Richman.

Cast iron, having a maximum pearlitic structure, has always been looked upon as the ideal for castings, having to withstand heavy duty, such as wear, heat, or impact. In the past some thousands of tons have been produced under ordinary foundry conditions with an analysis within the limits of 1.2 to 1.4 Si; 0.6 to 1.0 P; 0.8 to 1.0 Mn; and 3.4 to 3.5 T.C.

For steam engine practice this class of iron gave good results as regards wear and physical test. The Admiralty transverse test of 30 cwts. on a 2 by 1 by 36 in. bar and 12 tons per square inch tensile could be obtained without much trouble. With the advent of the internal combustion engine, engineering firms turning over from steam engine to Diesel engine manufacture experienced a great deal of trouble from cracked cylinder heads, growth and distortion of pistons and cylinder liners.

It was found that the percentage of total carbon, silicon, and phosphorus must be kept as low as possible—the phosphorus most particularly, as, if the T.C. and Si were right and the phosphorus were high, the castings would not last long under repeated impact of an explosive engine. This experience caused research workers to look for a high duty iron that would stand up to the severe conditions.

Semi-steel was about the first high duty iron that came along to claim its superiority over all others. This was supposed to have originated in America, but has been proved otherwise by Turner. The use of steel in the manufacture of semi-steel was more for the lowering of T.C. and its effect on the condition of the graphite more than anything else.

Lanz Perlit.

More recently foundrymen have heard of Lanz Pearlitic cast iron. In the Lanz process it is claimed that by pre-heating the mould previous to or after casting, an iron can be used lower in

FIG. 1.—LANZ × 500 DIAS.

T.C., P, and Si than in ordinary cold-mould practice. It is further claimed that the resulting iron is superior in most respects to ordinary cast iron. One can readily understand that by pre-heating a mould an iron can be used lower in Si and T.C. than would be possible in cold mould practice.

Together with the mould at a certain temperature, the iron must be of a definite composition to suit a casting of a certain thickness. It is claimed that this iron, when cast into a cold mould, gives a white fracture. The physical properties claimed for this iron are very high, and castings have the same structure in thick and thin sections alike; this fact is claimed to eliminate practically all wasters other than purely foundry wasters due to faulty moulds or cores

The actual analysis of Lanz iron we know very little of. One hears of Si well under 1.0 per cent. and T.C. 2.8 per cent., with phosphorus not above 0.1 per cent. If this is correct, it will be very interesting to hear how 2.8 T.C. can be produced at will from the cupola. It looks more like an air furnace iron for steel works rolls.

The Thyssen-Emmel Process.

Another process of producing a maximum Pearlitic iron is the Thyssen-Emmel process. Here, again, we know very little about it, other than its wonderful qualities. From a foundryman's point of view, if the claims are anything to go by, this method appeals to one, perhaps, more than the Lanz method, owing to the composition of the iron, except the T.C., being more in line with the irons used in most foundries.

From a test and analysis report on some Thyssen-Emmel iron by the Yorkshire Testing Works, the analysis is given as T.C. 2.64, C.C. .83, Si 2.14, S .159, P .25, Mn 1.37, which gave a tensile of 26.79 tons per square inch and 1 per cent. elongation, and a transverse test of a round bar gave a result equivalent to 45 cwts. on a 2 by 1 by 36 in. The test bar gave a Brinell hardness of 255. As to the analysis, the T.C. content is very low: it is the process of producing a low T.C. iron that is the secret of the patent. Most remarkable is the high silicon content; this is where it differs so much from the Lanz iron. The physical tests are exceptionally good, and are far above that claimed for Lanz iron. The Brinell number seems very high, and the author feels sure if foundrymen made castings as hard as 255 Brinell they would have the machine shop people complaining, as the author has found that 230 to 235 about the limit.

Basic Principles.

Definitely, to understand what pearlitic cast iron really is, one must closely examine what actually takes place when molten iron solidifies. Cast iron cannot be said to have a solidification point, but a range in which the different constituents solidify out. The analysis, mass effect, latent heat, and rate of cooling, all govern the length of the range. The lower the percentage of impurities in cast iron the shorter the range, and higher the temperature at which solidification commences.

At about 1240 deg. C. cast iron commences to solidify, and, just immediately afterwards, the iron carbide, which is not very stable in the solid form at high temperatures, starts to split up, forming primary graphite and ferrite, the latter depending on the composition of the iron.

The amount of graphite thrown out of solution depends on the amount of carbon, silicon, phosphorus, manganese, sulphur, and rate of cooling, the first two constituents and the last condition having the greater effect.

The rate of cooling is governed by the size and thickness of the casting, casting temperature, temperature of the mould, the latent heat of the iron employed, and the conductivity of the sand. Cooling continues down to about 940 deg. C. when the phosphide eutectic solidifies. This point is the end of the solidification range. The amount and condition of the phosphide present is governed by the amount of phosphorus in the iron and the rate of cooling. Being the last constituent to solidify out, it naturally tends to segregate into patches, but if the percentage is low and the existing conditions favourable, it forms into a meshwork formation around the crystal boundaries of the iron. To obtain this desired condition, the rate of cooling must not be too slow. Secondary graphite still continues to be formed right down to about 750 to 700 deg. C., but cannot grow very large owing to the material being completely solid.

The remainder of the carbon in the iron that has not been thrown out as graphite carbon, and is still combined with the iron, is left as pearlite. This pearlite consists of alternate layers of ferrite (almost pure iron), and cementite,

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. J. Masters presiding.

which is iron carbide in the proportion of 7 of ferrite to 1 of cementite, the whole having about 0.9 per cent. carbon unless other elements are present to affect this.

It can be readily seen from the foregoing facts that quite a number of changes in the ultimate structure of the iron can be made by slight variations of analysis and rate of cooling. Advantage is taken of this fact in the production of pearlitic cast iron. Pearlite and graphite are very closely associated with each other in cast iron; often in poor iron there is a layer of silicon-ferrite separating them, but under specially controlled conditions it is possible to obtain a wholly graphite and pearlitic structure without any free ferrite being present. This can only be accomplished by working to very fine limits as regards the actual analysis of the cupola mixture, melting losses, the conditions during the passage of the iron through the cupola the ultimate analysis and the rate of cooling through the critical stage, for a certain mass and size casting to be produced. The mass having a very large effect on the ultimate structure, it is claimed in the Thyssen-Emmel process that, no matter what mass is cooled, it is pearlitic.

Superheated Iron for Heating Moulds.

The effect obtained by pre-heating the mould by the Lanz process can also be obtained by casting at a very high temperature into a warm mould: the mould being warm avoids a sudden chilling action of the metal when entering the mould.

The pearlite formed can be of a coarsely-laminated nature, or a fine unlaminated condition, depending again mostly on the Si content and rate of cooling. Sorbite is the name given to this unlaminated pearlite, and not able to be resolved at the highest magnifications, and is the most desirable condition in cast iron when accompanied with small, fine, curly graphite. To obtain this ideal structure, an iron having a very low

FIG. 2.—CAST-IRON LINER × 500.

Si, P, and T.C. content must be used. Owing to the effect of the other constituents of cast iron and the rate of cooling on the condition of the carbon, total carbon should not be above 3.2 per cent., or large, straight flake graphite is likely to be formed. Phosphorus should not be above 0.3 per cent., preferably under 0.2 per cent., owing to its tendency to segregate.

Casting with a high percentage of superheat and the subsequent fairly slow cooling through the critical stage, even a small percentage of phosphorus is likely to segregate. When this happens, the resulting iron does not give such high physical tests as when the phosphide is in the most desirable fine meshwork formation. Moderately-high manganese is desirable, but not essential, as long as there is enough present to look after the sulphur, and help the stability of the pearlite, as the effect of the manganese remains to help to hold the carbon in the combined state. Sulphur is usually fairly high in low-Si irons, but this fact does not seem to have any detrimental effect on pearlitic cast iron up to about 0.13 per cent. Seeing that casting very hot is an essential condition in the production of pearlitic cast iron, it may account somewhat for the latter fact.

Internal Combustion Engines.

When investigating the physical properties of cast iron suitable for internal-combustion engine castings, one must consider the conditions to which the castings are subjected. The three most important conditions are:—(1) High temperatures; (2) repeated impact; and (3) hard wear.

Discussions upon the resistance of cast iron to high temperatures should take into consideration the cause of growth. The most potent cause of growth in cast iron is usually owing to the presence of *large graphite flakes* in the free ferrite of the metal structure. Free ferrite, which is silicide of iron in solution, when present in cast iron is in the vicinity of the graphite, and the hot gases burn out the graphite, and so access is made to the free ferrite, which is attacked and oxidised into silica and iron oxide. Owing to these substances having a larger volume than the substance from which it was formed, small cracks are formed, the sides of the cracks opening slightly, and so growth is made.

In conjunction with high temperatures existing in an internal combustion engine, the repeated impact of the explosion calls for a tough, strong iron. The two chief weakeners of cast iron are graphite and phosphide, the graphite being a non-metallic substance, filling up small cavities. The phosphide when in large percentages forms into patches, which are very brittle, and so lowers the resistance to impact.

An iron which has to stand up to hard wear must be free from large flake graphite, and any substance of a soft nature in its structure, such as free ferrite, silicon ferrite being the softest constituent of cast iron

This sums up the points to be avoided in iron suitable for internal combustion engine castings. This leaves us with pearlitic cast iron as having none of the defects stated previously, and which is at the present time the best iron for high duty work.

Inherent Difficulties.

To produce a suitable iron from the cupola and repeat the result from day to day, and often having to vary the mixture during the same day's blow, for different thicknesses of castings, brings one up against a certain number of difficulties.

Take the T.C. content with low-Si and phosphorus, the tendency is to absorb carbon, and very often hematite iron has to be used to obtain the low-phosphorous content. Hematite iron is usually high in T.C., in fact all the conditions are favourable to carbon absorption. Another difficulty which all foundrymen will readily appreciate is repeating the same analysis from day to day.

To obtain consistent results it is essential to keep the analysis within fairly fine limits. Small variations in Si when the Si content is under 1.0 per cent. and T.C. when in the region of 3.1 per cent. to 3.2 per cent. make a very large difference to the resulting iron. Ordinary foundry pig-irons can be used as a basis for making up the mixture. By ordinary pig-irons is meant pig-irons other than special irons, semi-cold blast or cold blast irons, costing under £6 per ton. This point is very important as special pig-irons are high priced.

Steel Additions.

The economic situation in the engineering trade to-day calls for a good class casting at as low a price as possible. A point here that is of importance—often it is cheaper to buy with an analysis than "to" an analysis.

The drawback with all ordinary pig-irons to-day is the high T.C. content; one hears of this trouble on all sides. The cause of this is perhaps the unremunerative state of the pig-iron trade, which tends to the forcing of the blast furnaces to produce quantity instead of quality. To counteract the high T.C. and reduce the Si raw steel additions are made in the mixture which lowers the carbon content within the limits required, this latter depending on the cupola conditions.

Very often one hears that the use of steel is condemned because it does not give consistent results. The Author's experience is that it gives consistent results if the cupola practice is consistent. The reasons for using steel are as follows:—Cheapness; slight reduction of T.C.; and its beneficial effect on size and shape of the graphite.

Melting Conditions.

When using steel in the cupola, the blast pressure and volume are very important, especially the latter. Low pressure with big volume is the best practice, and these should be kept constant all through the blow.

The Author uses a 30 in. cupola for the cylinder iron and blow 8 oz. pressure with a volume of 24 cub. ft. per sec., with a coke consumption of 8 to 1, the weight of the charge being 7 cwt. The metal should not be tapped out in small quantities, but as far as possible to tap 2, 3 or 4 charges at one time. All of these small details make for consistent results.

Some foundries run down a steel mixture into a pig bed, and then use this in the charge as a hardener. Both methods have been tried over long periods, but using steel direct into the charge gives the best results. The second melting gives the steel (or the steel mixture) the chance to pick up its surfeit of carbon and sulphur. The cylinder charges are made up of 20 per cent. to 30 per cent. steel scrap, No. 3 Scotch iron cylinder scrap and No. 4 hematite—the last-named is used to lower the phosphorous content for liners, pistons and cylinder heads.

Cylinder Metal.

Table I details the analytical results obtained between 16/7/25 and 16/9/25, and will illustrate the usual results for cylinder castings having a thickness of $\frac{3}{4}$ to $1\frac{1}{2}$ in.:—

TABLE I.—*Analysis of Cylinder Metal.*

Si.	P.	C.C.	T.C.	Mn.	S.
0.93	0.2	—	3.2	0.56	0.11
1.07	0.23	0.79	—	—	—
0.98	0.2	—	—	0.6	—
0.93	0.2	0.85	3.18	—	0.1
0.93	0.21	—	—	0.49	—
0.96	0.2	—	3.2	—	—
0.93	0.23	0.86	—	0.56	0.12
0.93	0.27	—	3.22	—	—
0.89	0.24	0.9	—	—	0.1
0.90	0.22	0.87	—	0.7	—
0.93	0.2	—	3.21	0.68	0.115
0.90	0.21	0.89	—	—	—
0.89	0.19	0.87	—	0.6	—
0.90	0.2	—	3.19	—	0.1

For thinner castings the Si is brought up to 1 per cent., whilst for castings from $2\frac{1}{2}$ up to $3\frac{1}{2}$ in. thick the Si can be lowered to 0.85 per cent. This is as low as has been obtained having regard to an Si content consistent with producing a machinable casting.

Hardness.

One important test is the Brinell hardness as it indicated the machinability and wear. The Brinell hardness sought, and which gives the best results so far as wear and machining qualities are concerned, is 190 to 195 taken on the liner bore after being machined. The hardness is controlled by a number of conditions other than the combined carbon. The amount and size of the graphite present, the presence of coarsely laminated pearlite or a fine sorbitic-pearlitic structure, all affect the hardness.

The Brinell number may seem low, but according to the claims of Lanz iron, this is about the hardness that is claimed as giving the highest wearing qualities. Personal experience is that up to 200 Brinell hardness, no machining difficulties are experienced, but after this point the speed and feed of the machines have to be reduced.

Representative test bars for transverse and tensile tests cannot be cast separate from the casting as this iron when cast in a cold mould has a white skin and mottled centre. When cast in a dry-sand mould at the same temperature as the casting it represents, it is much harder than the casting, having a C.C. content of 1 per cent. and a hardness of about 220. The best way is to cast it on the casting as near as possible to it with a number of runner inlets from the casting into the bar so as to obtain as far as possible the mass effect and slow cooling of the casting. Thirty-eight to 40 cwt. transverse on a $2 \times 1 \times 36$ in. bar with 0.7 in. deflection can be obtained fairly regularly; naturally the test varies, but the figures given represent an average.

Tensile Strength.

The tensile bars taken from the $2 \times 1 \times 36$ in. machined down to $\frac{1}{2}$ sq. in. area gives an average of 17 tons tensile. All castings cast in this class of iron are cast very hot: the metal is never held up owing to its being too hot; pouring temperatures taken at various times with an optical pyrometer average 1,380 deg. C. Naturally this metal "goes off" very quickly and requires to be handled expeditiously. Any spare metal is poured into pig so that it will not effect the next tap.

(To be continued.)

Note on the Characteristics of Pig-Iron.*

BY J. H. FLEMING.

The author pointed out that these pig-irons were divided into two groups, according to their content in phosphorus:—

Hematite pig, the P content of which was from 0.03 to 0.07 or even 0.1 per cent, which was mainly used in the production of acid Bessemer steel and acid open-hearth steel, and in foundry work for chill moulds slag pots, charging doors, etc., and to make mixtures of metal for strong and tough castings. The best were also used for making malleable castings. (The author gave various analyses.)

Foundry and Forge Pigs.—In these the P content varied from 1 to 1.75 per cent., and that of Si from 2.5 to 3.5 and even 4.1 per cent. They were generally mixed with scrap cast iron.

There were also special pigs of much higher strength than those already mentioned, owing to a low P (0.4 to 0.6 per cent.) and of total carbon (3 to 3.1 per cent.). As they could not be obtained from the ordinary blast furnace, recourse was had to cold-blast pig (used for rolls, steam engines, and Diesel cylinders). In these pig-irons the manganese played an important part in regard to the strength, fluidity, and closeness of grain. It was possible that it increased the stability of the pearlite.

The author gave various analyses of ordinary and refined standard pigs, and indicated the purposes for which they might be used.

For malleable castings, refined pig-iron was preferable, in order to have, first, a good analytical uniformity, and next, a low sulphur content, the effect of sulphur being to retard decarburation (less than 0.1 per cent. of S). A low content of total carbon was also necessary. The thinner the castings were to be the greyer the metal should be.

The author also gave a series of analyses of metals giving, in malleable castings, an average tensile strength of 20.5 tons per sq. in., with an elongation of 5 per cent.

Catalogues Received.

Foundry Equipment.—We have received from The Foundry & Engineering Company, of Albion, West Bromwich, five pamphlets each of which describes and illustrates a foundry specialty. A solid fuel fired sea-sand dryer carrying an automatic discharge; a substantially constructed core-drying oven, having proper insulated framework and moisture evacuation arrangements; foundry trolleys and machine-finished cast-iron moulding boxes, have each a pamphlet devoted to its description. A six-page folder is devoted to drying stoves, and in it is discussed the potentialities of solid, liquid and gaseous fuel, whilst the utilisation of waste heat from existing furnaces is discussed and an example is given from practice. The pamphlets are of a neat, uniform get-up. If this firm follows the method used by some concerns of supplying a folder or binder for filing new sheets and the replacing of obsolete ones, they will find the last one to be reviewed—"Drying Stoves for the Foundry"—unsuitable for many systems on account of the folding.

* Abstract of a Paper read before the Liege Franco-Belgian Congress.

XUM

British Cast-Iron Research Association.

The annual general meeting of the above Association was held at the Midland Grand Hotel, St. Pancras, London, on November 18. The meeting was followed by luncheon, Sir John Dewrance presiding. Among those present were the following:—Engineer Vice-Admiral Sir Robert Dixon (Engineer-in-Chief of the Fleet), Sir William Ellis (President of the Institution of Civil Engineers), Mr. C. E. Lloyd, M.P. (President of the National Federation of Iron and Steel Manufacturers), Mr. A. L. Hethrington (Department of Scientific and Industrial Research), Brig.-Gen. Magnus Mowatt, Sir Horberry Mensforth, Mr. H. Kerr Thomas, Dr. W. Rosenhain, Mr. M. Deacon, Mr. V. C. Faulkner (Vice-President of the Institute of British Foundrymen), Mr. H. B. Weeks, Sir R. Robertson, Mr. F. W. Firth, Professor H. C. H. Carpenter, Sir William Jones, Dr. H. Moore, Sir R. Gregory, Mr. H. J. Skelton, Professor Boswell, Mr. O. Stubbs, Mr. R. O. Patterson, Mr. J. A. Smeeton, Dr. Hutton, Mr. S. E. Dawson, Mr. H. A. Hartley, Mr. W. B. Parker, Major C. Howl, Mr. W. H. Whitehouse, Mr. H. Shannon, Mr. W. R. Bates, Mr C. Retallack, Mr. H. Field, Mr. T. Donaldson, Mr. F. C. A. H. Lantsberry, Mr. F. J. Cook, Mr. H. G. Sommerfield, Major Tavernor, Mr. Fearnley Allen, Mr. Roy Stubbs, Mr. H. Shannon, Mr. Paul Booth, Mr. W. Jolley, Mr. W. E. Hale, Mr. Berresford, Mr. J. T. Goodwin, Mr. J. E. Fletcher, Mr. J. G. Pearce (director and secretary), Mr. F. K. Neath, Mr. H. Coggan, and Mr. H. Winterton.

The report and accounts having been adopted, the following officers were elected:—As President: Sir John Dewrance, K.B.E. As Vice-presidents: Sir William Ellis, G.B.E., D.Eng., Mr. F. W. Firth, Mr. S. Hunter, C.B.E., Mr. W. B. M. Jackson, Mr. C. E. Lloyd, M.P., Mr. G. Pate, O.B.E., Commander Sir A Trevor Dawson, R.N., and Mr. A. P. M. Fleming, C.B.E., M.I.E.E. As Members of Council: Mr. J. T. Goodwin, M.B.E., Mr. C. Retallack, Mr. S. H. Russell, Mr. H. Shannon, Mr. O. Stubbs, Mr. W. H. Whitehouse, Mr. J. N. Wiggins, Mr. W. R. Bates, Mr. W. Jolley, Mr. J. E. Hurst, Mr. W. E. Hale, Professor T. Turner, and Mr. T. Bladen.

Sir William Ellis, Vice-President, President of the Institution of Civil Engineers, in his remarks after the luncheon, referring to Sir John Dewrance, said that Sir John had done more work in the development of science and research than most men to be associated with engineering, and industry owed a great debt to him. To Professor Turner they also owed much for the solid work he had done for so many years past. Sir William said the difficulties to-day were to some extent not so much in cast iron as in steel castings, and he would like to know whether there had been as much relative progress made in the physical properties of iron castings as had been made in various directions in connection with steel. He was afraid there had not been that progress made. Referring to engineers specialising, he wanted to bring before all the fact that foundry work was only one section. smithing or forging work were others, and, instead of engineers taking a general course of engineering, it would be much to everyone's advantage for them to specialise in one particular branch. In foundry work every one realised there was a livelihood full of interest and possibilities of great development. The difficulty in obtaining a manager with foundry practice was ten times greater than finding a man with general knowledge. He was assured there was room for the specialist. In the matter of centrifugally cast pipes, he was of the opinion that this country was ahead of all others. Difficulties had been overcome by the Stanton Iron Company by the expenditure of large sums of money. Had the problems solved at Stanton been dealt with on a scientific co-operative basis they could have been accomplished much more cheaply. That was a distinct instance of what could be done by scientific application of work in the foundry industry. Concluding, he wished the Association every success and regretted his inability to take a more active part in the affairs of the Association.

SIR JOHN DEWRANCE, K.B.E., President, hoped that the Association would flourish beyond all expectations. Research was a subject with which a great deal of his time was occupied. This nation was first in the development of engineering, and it had been a great advantage for many years, but this position was not now any longer one upon which reliance could be placed.

What was relied upon now was quality and knowledge of what was required. We had not yet obtained all the knowledge wanted, and the only way to get it was by research; therefore this country must be foremost in research, and that meant a great deal. The nation could not afford to let others do the research for them and then reap the benefit. The nation which was in the forefront of research and knowledge had the best chance of being in the forefront of industry. Referring to the Association, he wished all to make every possible effort to bring the advantages of the Association before all the cast-iron founders in this country so that they might do everything in their power to make themselves a self-supporting Association within their first five years of existence. The idea of this, their first luncheon, was to bring their activities before those who could help them in realising their ambitions—to be self-supporting, and also increase their membership. He referred to the fact that the Government grant, through the Department of Scientific and Industrial Research, which was given for a period of five years, would expire in 1926. They must realise this and make themselves self-supporting.

ENGINEER VICE-ADMIRAL SIR ROBERT DIXON, K.C.B., Engineer-in-Chief of the Fleet, said he was very much interested in the work of the Association. Under modern conditions more reliable and better material were required for the construction of His Majesty's ships, their machinery and arms. He felt that it was only by research work carried out systematically and on scientific lines that the desired results could be obtained. The use of cast iron had to some extent been abandoned for other materials and alloys, but cast iron is still used to a very great extent in the Navy. Research work on cylinders and pistons was most interesting. Lately he had been using steel liners with pistons of aluminium alloy; all were no doubt aware that the latter material had its disadvantages. It was due to the Association, he said, that he was able to specify more definitely the Admiralty's requirements of malleable cast iron. Referring to Sir William Ellis's remark on foundry practice, it appeared to him (Sir Robert) that foundry practice was not keeping pace with the requirements of the users. With that statement many of the manufacturers would no doubt disagree. Although the present practice was no doubt splendid, he was doubtful whether it was equal to modern requirements. The percentage of failures in castings was much too high. Research in regard to foundry sands, cupolas, pouring temperature, and melting temperature, etc., at all events by the Association, would be of the greatest value to the foundries of the Royal Dockyards, where a considerable amount of cast iron was produced every year. We have heard a great deal about pearlitic cast iron, and it was interesting to see from the Association's report that they were carrying out research on that type of iron, and if the results of this research were substantiated in practice, then we should get castings for Diesel engines which remedied some of the troubles being experienced at the present time. Concluding, he emphasised the necessity of research work. It was only in that direction that the country could make the improvements so necessary.

MR. C. E. LLOYD, Vice-President, President of the National Federation of Iron and Steel Manufacturers, wondered whether cast-iron research was not very much overdue. He had been thinking of an engine a hundred years old which had recently come to light, and was found to possess a cast-iron connecting rod, shaft and crank. This engine had worked for more than a hundred years without failure. He said that this country was apt to take too depressing a view of itself, and did not emphasise its good points. We had all that capacity for beating our competitors. Industry backed by research was going to carry us through our

difficulties if we were given a fair show in the markets of the world. He hoped everyone would not get hold of the ridiculous idea that we were falling behind our competitors. In the matter of development and invention we were doing magnificent work. Referring to Sir Robert Dixon's statement that foundry practice was not altogether satisfactory, he asked if it was not partly because we could not keep the best men here; they were nearly all going to America. The output of pig-iron there was six to seven times what ours was, but their population was not six or seven times larger than ours. Also, whereas the American depended mainly on an internal market, we had an export market to look to. Conditions were not entirely wholesome for the development of trade, but he did not think industry was wholly or mainly to blame for much of the depression which prevails in this country. As makers of pig-iron or castings they (the Federation) were concerned with furnaces not easily governable. Even when materials of exactly the same apparent constituent are manufactured they do not always turn out to have the same physical properties. What was needed was a co-operative spirit in research. One of the differences between this country and the United States was that they were much more ready to share information than we were, and if the B.C.I.R.A. broke down that isolation, they would do splendid work.

MR. A. L. HETHERINGTON, Department of Scientific and Industrial Research, was concerned not so much whether one could afford to become members of the Association, but whether they could afford not to. He suggested that they should ask themselves whether their business was so technical or so perfect, or with regard to competition, whether they "feared no evil," and if they had any doubts on that subject, then they had every reason for becoming members of the Association. No firm in the industry should stand aloof in the march of progress. A large number of small firms could not possibly maintain a scientific staff of their own, but owing to there being a central Research Association in existence, they could all look on the scientific side for a very small cost. He agreed with previous speakers that co-operation in industry was essential to progress. It was not sufficient to keep up to date, but it was also necessary to be an active participant. The Association, being controlled by the industry itself, reaped the result of the research carried out by the Association.

DR. W. ROSENHAIN emphasised the need for co-operation in research, and also the absolute necessity of translating it into practice. Research without application was of little use. The future of their Research Association was a matter of profound importance to the iron foundry industry of this country.

Publications Received.

The London, Midland and Scottish Railway Company have sent us a map of London, mounted on stout cardboard, and provided with cord for hanging on office walls. For any firm despatching goods by rail to or from London this map is almost indispensable. The free collection and delivery area is indicated, all goods and passenger stations and coal depôts are clearly shown. The borders are utilised for carrying a description of the facilities afforded at the principal goods stations and depôts. We strongly advise our readers who do business in the London area to provide themselves with a copy.

AT DUDLEY COUNTY COURT, on Thursday of last week, before his Honour Judge Tebbs, application was made for the discharge in bankruptcy of Mr. E. F. Burston, of Goldthorn Hill, Wolverhampton, and Mr. J. Whitehouse, of Hagley, formerly trading as Burston, Whitehouse & Company, at 7, North Street, Dudley, as iron and steel merchants. The Official Receiver stated that the liabilities amounted to £993 and the assets had realised £124. No dividend had been, or could be, paid to unsecured creditors. On making an offer to pay £30 to meet the claims of preferential creditors, his Honour granted an immediate discharge.

The Manufacture of Propellers.*

By M. HUBERT GIL, Engineer, Arts et Métiers.

The author recalled the fact that bronze composed of 88 Cu and 12 Sn was adopted at once and almost exclusively for marine propellers, owing to its mechanical properties and its resistance to oxidation. The test conditions imposed in 1890 were: A tensile test, showing maximum stress, elastic limit, elongation, and a shock test on a notched bar. The latter was subsequently discontinued when it was found to be merely a needless repetition of the previous test. The mercantile marine required as a minimum: Maximum stress = 22 tons per sq. in.; yield point = 7.6 tons per sq. in.; elongation = 20 per cent. The bronze made it difficult for these values of the maximum stress and the yield point to be obtained, while it gave an elongation which might reach 50. Attention was soon turned, therefore, to the use of special high-resistance brasses, such as Stones, Delta, Roma, Volga, Tenax and other metals, and to what are called manganese bronzes, which enabled the maximum stress to be increased to 41 tons, the yield point to 15.8 tons, while the elongation, on the other hand, decreased to about 15 per cent., when the maximum stress was 41.2. Thus a large number of companies preferred to keep elongation about 25 per cent., and have only a moderate tensile strength.

It was to be noted that the high tensile aluminium alloys, such as Al-Cu alloys, were unsuitable, as they cast up badly. In every respect the casting of such brasses was a delicate operation, and required very careful treatment.

But, in addition, there appeared in the castings two kinds of defects which, generally, did not show in the rough casting, and did not arise in any way from the composition of the metal. The first—termed by M. Gil "erosions"—was found in the thin portions of the casting, for example, towards the extremity or the edge of the propeller blades, and had the appearance of small bubbles. These were, in fact, discharges of gases imprisoned in the metal when cooling—either gases arising from the humidity of the mould or gases (CO_2) occluded as a result of imperfect decarburisation or deoxidisation of the metal. The hotter the metal had been cast the larger these erosions were. Their inconvenience was relatively slight from the point of view of the tensile strength of the castings. They might be prevented by casting at as low a temperature as possible in a very dry mould and with well deoxidised metal.

On the other hand, the second kind of defect termed "corrosions" affected the thicker parts of the casting, and was of great importance mechanically. In machining, only brown spots were sometimes found, but if the casting were drilled cavities were frequently discovered; the metal was composed of large grains or of a network of crystals with large interstices. When in service, the sea-water attacked the metal very sensibly, and the casting was rapidly thinned down until it was insufficiently resistant, and broke. This defect was due to the casting, arising more particularly from contraction, which was all the greater, as the tensile strength of such alloys was itself considerable. To prevent it, in addition to suitably designing the castings when possible, large feeding heads must be used, and possibly chills suitably placed, while, as before, the casting must be done at as low a temperature as possible, in order to lessen the shrinkage, and as rapidly as possibly.

The particulars given by M. Gil with regard to propellers obviously apply to all castings made with these special brasses, the use of which is increasing in the trade.

Rail Production in Japan.—In certain quarters, says "The Iron Age," it is expected that in the near future the Imperial Steel Works at Yawata will be in a position to supply practically all Japanese 60- and 70-lb. rail requirements, both governmental, including the South Manchuria Railway and the Korean State Railways.

* Extract of a Paper read before the Liege Franco-Belgian Congress.

Commercial Aspects of Foundry Work.*

By J. S. C. Padfield.

The commercial factors are, after all, governing factors. If orders are not obtained for castings, or if they are sold at a continual loss, or bad debts become too frequent and the commercial management inefficient, the apparatus of technical efficiency and practical effort cannot achieve success. It must be, and without doubt is, the aim of every foundryman who respects himself and his work to produce the best he can, but he is dependent for his continuance on well-doing to agencies to which at times he fails to give full credit. The foundryman, *per se*, needs to ask himself occasionally how the business was, or can be, established, how it is run, and how to be maintained in a prosperous condition. For without this element of commercial prosperity and success, it is obvious that, sooner or later, an enterprise must come to an end; that is, of course, for foundries which depend for their existence upon castings sold and are not merely adjuncts to other and larger concerns, or are part of the maintenance plant, say, of a great railway, which derives its profits from the public in another way.

Basic Principles.

The following fundamentals are assumed: That whilst foundries—as do other industries—perform a public service, in that commodities are produced which are really necessary for the comfort, progress and well-being of the community, yet unless certain economic factors are taken into account the industry will not yield satisfaction to those engaged in it.

That whilst to pay good wages, secure a reasonable margin of profit, and increase the efficiency of the industry should be, and probably is, the aim of all engaged in it, these results cannot be achieved unless due consideration is given to these factors.

Castings—generally speaking—are made for sale, and unless profitably sold an end will soon come to the operations of the foundry working consistently at a loss. The art of *selling* is not so simple as some appear to think; given the *aptitude* there remains still much to be learned. Just as in the practical operations of a foundry original aptitude is an essential quality, to which must be added earnest application and patient endeavour, so with those deputed to sell the products. Salesmanship is both a science and an art. Instances could be cited of practical workers expressing a poor opinion of the salesman. Yet he is the man whose efforts are often vitally necessary to the carrying on and the prosperity of the business.

Castings must be profitably sold, which involves a competent knowledge of cost. One has to ascertain and understand what real cost is, to avoid cutting selling prices to and below the "losing" point.

It is a poor salesman who glories in cutting out an opponent regardless of what his own "cost" and "loss" may be. Not much talent is required to sell stuff below cost price. Just as anyone can make a "waster," so anyone can take an order at a price lower than the lowest offered. There are salesmen who have said "Whatever so-and-so's price is, I will go below it." That may sound magnificent, but it is poor war. Accurate costing must lie behind good salesmanship.

It appears that there are people in the foundry business who cannot know what their "cost" really is, or they are philanthropists hoping for better days. Even in a foundry run as an adjunct—or as a maintenance unit—there surely will be regard paid to "cost of production" in relation to outside market prices.

Castings, to be saleable, must be such as are required or ought to be required, that is, in demand or for which a demand can be created. This sounds very obvious, but it is a fact that some have spent much time and money endeavouring to sell an article nobody wanted and which in itself would not create a demand. When one has a new thing to offer it is useful to be self-critical and inquire—"Who wants it?" or "If they don't want it, are there such qualities in what is offered that they can be made to want it?" The Patent Records are loaded with ideas upon which disappointment and failure can be written because this operation of self-criticism was not performed or the opinion of a candid observer asked for.

Competitive Materials.

The most serious competitor to the foundry business has been, and still is, mild steel. Girders, columns, and other articles formerly made of cast iron have been substituted almost entirely by mild steel. Thirty years ago, when mild steel was beginning to dominate the structural trade, it was freely prophesied that foundries were doomed. However, things have not turned out quite so bad as feared, and cast iron has still a place of its own to fill. Cast steel is not so much a competitor as an adjunct. One has, however, continually to face the problem of advisability.

In the past the origination of ideas has generally been to the credit of the engineers, but thanks to such institutions as the British Cast Iron Research Association ideas are originating and being developed in the foundry. Hence to those who have ideas, it is advisable not to be over-sanguine, but rather to test the idea and then consult some capable business friend before launching it. Even if it is a good thing, remember that much hard work must be done and many disappointments incurred before an idea becomes a source of remuneration.

All things that sell well are such as recommend themselves, fill a vital necessity in social requirements, and can be sold at such a price as will enable or induce people to buy.

When one says that castings to be saleable must possess certain definite characteristics, one means that they must fill a need, or by their originality and efficiency create one.

Castings must be up to a standard of quality as to material. The selection of material is a vital part of the training of foundrymen, and something more than a knowledge of moulding is required. One must study the chemical and physical characteristics of iron, must know how to handle the various qualities of iron, must know the best coke for his particular purpose, and a host of other technical and quasi technical details. A foundryman must know how to buy these commodities, study the markets, watch the trend of business, and secure at the best price the best commodities for his use. If anyone thinks this is a very easy matter he will learn better after a little experience.

Castings are frequently judged by appearance, and are often rejected, to the loss of the producer because they look otherwise than the buyer desires. Foundrymen are always in the buyer's hands, and if they cannot please him they lose him. To avoid this, attention has to be given to many small details, and it is rather surprising to find how difficult it is to obtain recognition of this. Perfection is very difficult to obtain; it certainly is no trifle, but trifles go a long way to make perfection.

Importance of Credit.

There are, unfortunately for themselves, people who fail to see the importance of credit. When castings have good quality as to materials and finish—and supposing there are plenty of people eager to buy—one has to be satisfied that the prospective purchaser is in a position to pay for what he orders, especially in these days of financial stringency. In a small concern a bad debt is a great burden, and several may make it impossible to carry on. Often, however, credit is more carelessly managed in a small concern than in a large, well-organised undertaking. In every business, small or great, there should be one person whose function it is to control credit. One cannot always obtain cash before or upon delivery; business depends to a certain extent

* A Paper given before the Wales and Monmouth Branch of the Institute of British Foundrymen at Cardiff, Mr. P. Leonard Gould presiding.

upon credit, and therefore the importance of the function is apparent. Established and powerful firms have been broken down because this function got into the hands of a person ill-fitted to exercise it. Those who are concerned in practical production must try to remember that one who seems remote from us still exercises a vital contribution to the success of the undertaking in which they secure their livelihood.

One of the most unsatisfactory elements in the present industrial position is that so much of the little work being done to-day is paid for by the rate and taxpayer. It is well that this work is being done—perhaps more should be done—but do not let us delude ourselves by calling it prosperity. National prosperity has been built up on and must depend upon export trade.

We have to realise, too, that we no longer enjoy as Britishers an unchallenged position as a manufacturing people. We have now to face intensive and highly educated competition from great industrial nations which during the past two or three decades have made enormous strides.

There is room for all, if we are prepared to do our part, but there will be no place for any nation which does not visualise, face and conquer the difficulties of to-day.

At the moment there appears to be a movement in international trade favourable to us as a nation. It is to be hoped that it will grow and that nothing will occur to shake the re-establishment of confidence and credit.

We want the man in the workshop to think about these things occasionally. Are we not all "in the same boat"? If business is prosperous all share the benefit. If it is bad, unprofitable, no one feels the pinch so quickly as the manual worker.

So let us keep an open mind and a broad outlook, cultivate a mental attitude sympathetic to each other's difficulties, and at all times seek in the spirit of goodwill to do the best we can for the industry in which we are engaged.

DISCUSSION.

Replying to a question by MR. HIRD as to the benefit of payment by results, MR. PADFIELD replied that it was getting quite outside the scope of his Paper, but personally he believed in payment by results, which should not be stinted. He believed the weak man should be protected as far as possible, but the strong man should not be on the same level as the weak.

MR. SILVERWOOD asked for the fundamental principles of costing, to which MR. PADFIELD replied they were very simple and covered by the following equation:—Material plus labour, plus expenses, plus profit, equals selling price.

MR. LEWIS said he was pleased to see the above illustration, and expenses was a most important factor, covering such items as depreciation, etc. On two-thirds of the normal output it was possible to run comfortably, but when it dropped down to one-third it called for much anxiety. Pattern makers considered all the aspects from the drawing office to the finished job, yet most lose sight of the estimating part of the business. Some years ago the reason for the introduction of steel anchors was chiefly a strike. Only a 5 per cent. reduction was suggested, but it was not accepted, and the men went "out," not considering results. It was decided to make steel anchors, and they have been used since.

MR. P. LEONARD GOULD said he would like to ask Mr. Padfield how he arrived at his figure for expenses, whilst MR. FONTAINE elaborated the same question by supposing a foundry had an output of 10 tons, then averaged 5 tons, and were now doing 1 ton per week. MR. PADFIELD replied it was evident that in a case as stated by Mr. Fontaine the proprietor must be losing money, and that if the output was less than the average, outgoings must be taken out of what would have been profit in the ordinary way, or, in the case of a very small output, the proprietors must be using their capital or reserves.

MR. MCCLELLAND thought the object of the lecturer was to impress upon the young men points which they would have to consider if they were aiming at becoming proprietors. One of the difficulties was that we fixed the rates of expenses when the foundry was full. When working on two-thirds capacity the expenses remain almost the same, and when only doing one-third the expenses still remain. Really prices should be higher when work is scarce than when there is plenty, but the reverse is the case, because orders are so hard to get and prices are cut to "get in."

MR. KINSMAN was also interested in the expenses, and MR. PADFIELD explained that at each stocktaking the accountants obtain figures and average depreciation at a percentage.

MR. MCCLELLAND moved a hearty vote of thanks to the lecturer, which was carried unanimously. An invitation was extended to all to join in the forthcoming visit to the works of Messrs. Brown, Lennox & Company, Pontypridd, on January 27, 1926.

Cast-Iron Houses.

Messrs. Walter Macfarlane & Company, of Saracen Foundry, Glasgow, have sent us a four-page pamphlet which illustrates, by both line drawing and photographs, a bungalow type of cast-iron house. As we pointed out in our leader on the subject, the house is really a composite one. It incorporates standardised cast-iron plates for the outer walls. There is no machining on them, and the face of the plate is roughened to give the appearance of rough cast work. They are carried on cast-iron mullions, and are constructed according to "Macfarlane's patent special overlapping joint."

A PAIR OF "MACFARLANE" CAST-IRON BUNGALOW HOUSES.

We note that a claim is made that "cast iron as a material for outer walls is very durable, is practically imperishable, and *will last a lifetime if painted, say, every seven to ten years.*" This last claim, which we have italicised, is not sufficiently strong, and the claim, "is practically imperishable," is to our mind no exaggeration. The roof is composed of light steel trusses with wood boarding, felt, and red asbestos "slates" on top. We congratulate Messrs. Macfarlane on the enterprise shown, and wish them and all other foundrymen tackling this problem the fullest success.

A Good Cement for Furnaces.—Mix together burnt fireclay, 1 part; ordinary fireclay, 1 part; along with sufficient silica of soda to make it of a plastic nature.

Painting High-class Machinery.—There is nothing that spoils the look of machinery more than rough castings, bad painting, and general bad finish. This evil can easily and cheaply be remedied. Dress off all unnecessary projecting faces with a good sharp chisel. Rub the entire machine down (omitting, of course, machined and polished or buffed parts) with a sandstone. This having been done, give the machine one coat of thin oil paint of good quality. Allow to dry, and then fill up any blowholes, etc., with putty (made of lampblack or white lead) and gold size. This will set hard, although a first-class iron cement (mixed with water) would suit most purposes quite as well. Next, thin the mixture down to the consistency of treacle with spirits, and apply one more coat. Allow to dry once more and then rub down the machine to a fine smooth surface with pumice stone and water. For finishing, two coats of paint are all that is necessary. The result will be most pleasing and should be ample compensation for the time and labour spent in "getting up" the machine. Only first-class paint should be used.

Practical Points from Published Papers.—II.

By B. ROGERS.

Pointers for Improved Practice.

A study of the analyses given by Hatfield * reveals that West Coast Hematites have total Carbons of No. 1 Grey, 4.05; No. 2 grey, 3.95; No. 3 grey, 3.8; No. 4 grey, 3.8; No. 5, 4.0; mottled, 3.55; and white, 3.25 per cent. No. 5 is the only exception to a gradual decline in total carbon in Scotch, Welsh, East Coast and West Coast hematite irons. The total carbon drop in Lincolnshire iron from No. 3 to white is 0.7 per cent. In Derbyshire irons the drop is 0.8 per cent. from No. 1 (2 per cent. silicon) to white iron.

The present tendency is to aim at low total carbon and low silicon. Therefore, why not use a white iron composition? Why should not a white iron or a mottled iron plus certain elements be made into a suitable casting? The author is aware of white iron (and steel) being a success for certain hard surface and rolling purposes. Moreover, it has always been the basis for experimental purposes and malleable iron production. The dividing line between expensive cold-blast irons and white irons is largely that the former have a low total carbon of 3.2 to 3.7 per cent., of which 0.3 to 0.4 per cent. only is in the combined condition. Now this is a high melting-point iron, which necessitates additional coke. Still it brings up the temperature for casting and ensures a hot pouring. However, unless proper cupola melting is carried out, high coke consumption is added to a high price for iron. White iron containing mostly combined carbon will melt easily, and will require less coke, besides being a cheaper iron.

It will contain high sulphur and it will be sluggish, but there are remedies on the market for sulphur elimination. The author is personally aware, from experience as a chemist, that a steel bar containing high sulphur will often roll satisfactorily if the manganese is sufficiently high.

Dr. Hatfield quotes Dr. Arnold and Dr. Waterhouse for 0.5 per cent. sulphur in steel working satisfactorily. He moreover recommends the Paper for study. This again suggests the idea that the limit of the influence of manganese has not yet been reached, in cast iron.

Wüst said "In iron containing 3.15 per cent. carbon and about 1 per cent. silicon, on an average 0.01 per cent. sulphur prevents the separation of 0.02 per cent. graphite—but with 2.0 per cent. silicon its effect is less." Roughly 0.4 to 0.6 per cent. graphite is prevented from separating by the sulphur content of poorest white iron containing 0.2 to 0.3 per cent. sulphur.

Dr. Hatfield quotes Freitscke and Tamman as having done excellent work on equilibrium of iron-sulphur system. One point of exceptional interest is the final separation of the remaining FeS from the solid solution at so low a temperature as 130 deg. C., and points out this fact alone indicates the advisability of giving more attention to the low temperature regions of phase rule diagrams. It is suggested it might be worth while to try the effect, in this connection, also, of various sulphur amounts upon just grey, *i.e.*, mottled iron. Dr. Stead states "It would appear that carbides will not carry in solid solution more than about 0.1 per cent. sulphur."

Drastic annealing failing to precipitate free carbon in his experiments, he concluded "that whatever other influence the sulphur may have, it is that portion which crystallises with the carbide which is mainly responsible for preventing the separation of graphite by making the carbide stable."

Again "The mutual neutralisation which sulphur and silicon effect with each other when present in an alloy is probably due to the production of a silicon sulphide." (Dr. Hatfield).

Although Keep does not attribute whiteness of cast iron to sulphur, Turner thinks with most, that it is often a cause of it. From the recent researches no reason can be assigned why higher sulphurs than formerly may be used. Such irons would need to be balanced by manganese. It is noteworthy also that hardness may be given to a casting by sulphur alone (sometimes known as sulphur chill). Hamasumi shows that manganese directly increases hardness with tensile strength. Both may be used judiciously to obtain high hardness numbers. Though there is a certain lack of continuity in this article, there is, however, much that can be seen to be inter-connected by facts.

* Cast Iron in the Light of Recent Research.

Influence of Shape of Graphite.

According to Northcott hardness and graphite-size are directly related to each other. This is a very valuable statement, and aided as Mr. Northcott was by Prof. T. Turner, it cannot be too strongly emphasised. Additionally certain other elements specially contribute to the hardness properties both in steel and cast iron, as for instance manganese, nickel and chromium.

In reading so much about graphite-size and its importance in cast iron, it has been stated that both semi-steel and Lanz pearlitic iron claim success in producing high-class irons, as a result of getting curly or small nodular graphite upon a pearlitic matrix. It has been already shown that Hamasumi confirms this point.

Since writing these articles THE FOUNDRY TRADE JOURNAL has published in its issue dated October 22, an article by Pipowarsky on Graphite in Cast Iron, wherein he strikingly confirms several of the above statements.

Professor Edwards, in a Paper read before the Swansea Metallurgical Society (1921) made several interesting statements in reference to time and temperature conditions. He said, "It will be readily understood [in reference to cooling of quenched and unquenched carbon steels] how impossible it would be to produce a material change in the hardness, and, therefore, the tensile strength, throughout a large mass of metal of this kind, simply because of the impossibility of getting the rate of cooling within the above-mentioned limits. [critical points and ranges]

"This difficulty can be overcome by the addition of such elements as nickel, chromium, tungsten and manganese.

"These elements, when present in steel, act internally, in the same direction as the operation of quenching. They decrease the facility with which the carbon separates from the above-mentioned solution.

"This method of internally retarding the change in the condition of the carbon can be carried to any desired degree up to the complete suppression of the change by varying the amount of the specially added element.

"The outstanding advantage, of, so to speak, putting a brake upon the carbide change, in this manner, is that the action is from within, and consequently practically the same effects are produced all through large masses of the materials."

That is a clear statement. Moreover all are agreed that cast iron is steel plus graphite, as pearlite is present in both.

It is thought there is scope for new alloys in cast iron on these lines, that is to hasten the change from austenite into pearlite for green sand work, as Hamasumi also recommends. Moreover, it is thought that the Lanz process is the result of experiments on similar lines, that is, the inclusion of the use of special elements as assisting control.

Again quoting Professor Edwards:—"I hope to stimulate other workers to give careful consideration to the influence of temperature and the quantitative examination of time. In the study of metals and their alloys we need to eliminate, as far as possible, such uncertain relative expressions as 'quick' and 'slow' rates of cooling. This is what the Lanz process indicates.

"The only satisfactory way is to state the conditions in some such form as the number of degrees fall in temperature per unit of time."

The Lanz Patentees admit that if some of the irons of particular compositions which they use were cooled in the ordinary way, the result would be a white iron.

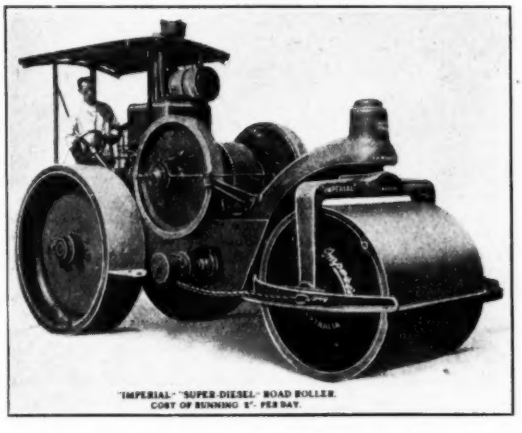
That is to say, for certain purposes they aim for a basic composition of a white iron and they vary the rate of cooling by heating the moulds to different temperatures in direct relation (known by patentees by experimental work) according to different compositions of irons and different sec-

tions or classes of work. This should necessitate the use of special elements in some cases as has been shown above, and that they do so can be easily confirmed indirectly by an examination of their patents relating to improvements in cast iron. The author inclines to the opinion that they are working on sound principles. Moreover, to equal their results, it will be necessary for foundrymen to adopt equally sound principles, if not the same methods. That is to say, the author would advocate basing experiments on an essentially white iron composition, and standardising all factors save one, as being the only scientific method. It is slow, but real development is generally slow. Even tea-tasters use this method to find out how to improve their quality. Surely cast iron demands the adoption of similar methods if progress is to be made?

An Australian Road Roller.

One of our readers, the A. H. McDonald & Company Proprietary, Limited, Imperial Engine Works, 570-4, Bridge Road, Richmond, Victoria, Australia, has sent us the photograph which we reproduce below of a Diesel-engined road roller. In their letter they state:—

"You will note that both the front and rear wheels are disc castings—there are no spokes to



"IMPERIAL" "SUPER-DIESEL" ROAD ROLLER.
COST OF RUNNING 2/- PER DAY.

come loose or give trouble, whilst in addition the front wheels can be ballasted with either fuel or water. In many country districts this is a decided advantage, especially as this roller only uses about 4 gallons of fuel and about the same quantity of water per day; consequently it can carry sufficient fuel and water to last for about six weeks' work."

We congratulate the McDonald Company on their enterprise in catering in such a satisfactory manner for the peculiarities of their own market.

Information on Moulding Sands.

Experiments to devise a method for running softening temperature determinations on moulding sands have been conducted by the Bureau of Mines, Department of Commerce, at the request of the committee on moulding sands of the American Foundrymen's Association. Experiments have been completed, and a report to the Committee is being prepared for its guidance in formulating the conditions under which moulding sands should be tested for refractoriness. In this work it has been necessary to determine first the effect of furnace atmospheres on the raw sand, the washed sand, and the bond used in forming the sand into moulds. Six typical sands were selected, and these were tested under both oxydising and reducing conditions. The softening range of the sand was determined on cones and test bars.

To Harden Wood Pulleys—Boil them for ten to fifteen minutes in Jews' olive oil and allow them to dry naturally.

Recovery of Waste in the Iron and Steel Industry.*

In 1922 a large blast-furnace and steel works plant in Westphalia installed a magnetic separation plant for dealing with the refuse from their blast and open-hearth furnaces and converters, and the recovery therefrom of any iron and steel scrap. After more than two years' operation the plant has clearly demonstrated the great advantage of such treatment of the refuse. Originally the plant was also designed to recover any combustible matter from the ashes of the various furnace installations in the works, but this became subsequently unnecessary owing to the change over to practically complete gas firing.

For the installation of the plant a particularly favourable situation was available, comprising railway sidings and junctions and an existing bunkerage, the arrival line being some 42 ft. above the level of the departure line, consequently it was only necessary to raise the raw material to a very small height in order to pass it over the magnetic separators and to let the products of separation drop into the bunkers below.

The waste material arrived in either-side clearing wagons, which were discharged on to a bar screen, the bulk of the material falling through into a hopper beneath, while only a small portion needed to be crushed on the screen. From this hopper the material was fed to an elevator by means of a shuttle truck. The elevator discharged into a revolving screen which graded the material into three sizes, each of which passed over a magnetic drum which separated the material into iron and waste (in the case of fuel into unburnt fuel and ash). The products thus separated dropped direct into the respective bunkers and from these could be loaded direct into railway wagons or ordinary tip wagons. The iron scrap, unburnt fuel, etc., were taken straight to the blast furnace, while the ash and other refuse was taken to the refuse heaps unless used for other purposes.

The separation plant was housed in a building consisting of a reinforced concrete frame filled in with brickwork, and was incorporated with the bunkers.

A number of points had to receive special consideration when designing the magnetic separators. In order to save the crushing of the material, the separators had to deal with pieces up to 400 mm. (nearly 16 in.) in length and 170 mm. (about 7 in.) wide in the case of shorter pieces. At the same time the working of the separating plant had to remain unaffected by variations in the size of material.

The bunkers, conveyors and elevators had to be adequately protected against abrasion by the sharp-edged material, and provision had also to be made to prevent the creation of dust.

The plant has satisfied all these requirements during more than two years' operation, having been specially designed for the work to be done after some preliminary experimental work.

During eight consecutive months in 1922/23 the average quantity of material handled was 3,375 tons, from which about 800 tons (equal to 23.7 per cent.) of iron and iron-containing materials were recovered. As the average iron content of this material was 66.38 per cent., the recovery of iron amounted to about 530 tons per month. The corresponding figures for 1924 were 3,100 tons of material treated, 500 tons of iron-containing material recovered, and average iron content 74 per cent., corresponding to 370 tons of iron recovered per month. This low yield was due to the iron content of blast-furnace waste being generally low owing to the greater efficiency of the workmen in controlling operations. The remaining refuse is practically free from iron, and the plant has developed an average capacity of over 10 tons of treated material per hour. To operate the plant and re-load the separated material into wagons during two shifts per day, 4 men per shift are required. The power consumption, including the current for the electro-magnets, is 15 to 20 h.p. Based upon the value of the recovered material, the cost of the plant was repaid in a few months' time.

* "Stahl und Eisen."

XUM

Trade Talk.

AN ENGINE-SHOP at Cammell, Laird & Company's shipyard at Birkenhead was destroyed by fire last Monday week.

THE UNITED STEEL COMPANIES, LIMITED, have received an order for 15,000 tons of rails for the Southern Railway.

THE BRITISH ALUMINIUM COMPANY, LIMITED, announce that the registered office of the company is now Adelaide House, King William Street, London, E.C.4.

AN EXPLOSION resulting in injury to five workmen occurred on November 13 on the premises of the Yorkshire Engineering Supplies Company in Upper Wortley, Leeds.

THE BOILERMAKERS' SOCIETY recently put before the Prime Minister a proposal that the shipbuilding industry should be subsidised from the Unemployment Fund. The Prime Minister has replied that the scheme is not feasible.

THE UNDERGROUND RAILWAY COMPANY have placed orders with Cammell, Laird & Company, Limited, and the Metropolitan Carriage, Wagon & Finance Company, Limited, for 78 new cars required for service on the Morden and Kennington extensions.

W. CANNING & COMPANY, LIMITED, 133 to 137, Great Hampton Street, Birmingham, have obtained registration of the name "Canning" as a trade-mark relating to electro-plating, polishing and lacquering machinery, including the necessary equipment and materials.

FOR THE PURPOSE of acquiring the whole of the ordinary shares of Brampton Bros., the directors of the Coventry Chain Company, Limited, propose to increase the capital to £715,000. This will entail the creation of 15,000 additional preference and 200,000 additional ordinary shares of £1 each.

OVER 100 MEMBERS of the Sheffield Society of Engineers and Metallurgists paid a visit to the works of the Stanton Ironworks Company, Limited, near Nottingham, on November 11, to inspect the works and specialities manufactured by this company. They were received by Mr. E. J. Fox (managing director of the company) and entertained to luncheon.

THE PNEULEC MACHINE COMPANY, LIMITED, Mafeking Road, Smethwick, near Birmingham, have now completed their selling re-organisation, and representation in Lancashire and Yorkshire and the Midlands is now being looked after by Mr. W. J. Hervey, Crofton House, Chorley, Lichfield, late of Alldays & Onions, Limited, and Thwaites Bros., Limited.

MR. F. W. BRIDGES, general manager, has issued an invitation on behalf of the honorary president and honorary committee of experts of the Shipping, Engineering and Machinery Exhibition to all visitors from overseas associated with the shipping, engineering and machinery industries who happen to be in England to attend the dinner to be given at the Exhibition on December 1 in honour of overseas' guests.

BIRMINGHAM now possesses the largest twin gasholders in Europe. One of these was formally inaugurated on Thursday of last week at the Washwood Heath Works, and the other will be available for use shortly. Each has a capacity of six million cubic feet of gas, and when, as is proposed, two further lifts are added the two holders will have storage accommodation for 20 million cubic feet. Four thousand tons of steel have been used. The tanks of the gasholders were built by Harold Arnold & Sons, Limited, of Doncaster. The tanks are of the mass concrete type, reinforced with mild steel rings, and each has a diameter of 254 ft. 3 in., and a depth of 45 feet. The order for the construction of the holders was placed with Clayton, Son & Company, Limited, of Hunslet, Leeds.

WEIGHING in all about 80 tons, and overhanging both sets of metals, the new stern frame for the White Star liner "Olympic," was transported by the London and North-Eastern Railway Company from the Darlington Forge Company's works, where it was made, to Middlesbrough, on Sunday. This constituted the first and most difficult part of the journey, for it is being conveyed from Middlesbrough docks by sea to Southampton, where it will be fitted to the "Leviathan." The conveyance of such an awkward load was a Herculean task, and recalled the time seventeen years ago when the Forge and the railway company successfully conveyed the original stern frame from the Darlington works to Middlesbrough for the same vessel, says the "Darlington Evening Despatch." The load was carried in two sections on separate wagons, and had an overhang of 15 ft. 9 in. from the centre of the six foot side of the line, and when in position on the wagons the extremity of the frame stood 13ft. in height from the metals. Not only did the frame extend outwards over the other set of metals, but also jutted over the platforms of stations passed en route in the course of the journey.

Company Reports.

Allen Everitt & Sons, Limited.—Interim dividend, 6s. per share, less tax, on ordinary shares.

Ewart & Son, Limited.—Dividend, 16 per cent. per annum on cumulative preference shares for half-year.

Brown, Bayley's Steel Works, Limited.—Dividend, 2½ per cent., free of tax, on preference shares for half-year.

British Thomson-Houston Company, Limited.—Dividend on 7 per cent. cumulative preference shares for half-year, less tax.

Dorman, Long & Company, Limited.—Dividend on preference shares, 6 per cent. per annum for half-year; no dividend on preferred ordinary or ordinary shares.

Coventry Chain Company, Limited.—Profit, £40,697; brought in, £12,495; final dividend, 7 per cent. on ordinary shares (making 10 per cent.), less tax; carry forward, £8,019.

Cargo Fleet Iron Company, Limited.—Brought forward, £212,899; profits, £72,953; depreciation, £30,000; debenture interest, £40,015; balance, £215,838; carried forward, £215,838.

South Durham Steel and Iron Company, Limited.—Profit, £93,931; brought forward, £203,815; interest on debentures, £13,500; dividend on 6 per cent. cumulative preference shares, £13,500; depreciation, £25,000; balance, £245,747; dividend, 2s. per share on ordinary shares, £35,000; dividend on 6 per cent. cumulative preference shares to September 30, 1925, £4,500; carried forward, £206,247.

Contracts Open.

Aberdeen, December 8.—Dredger, for the Aberdeen Harbour Commissioners. Mr. R. G. Nicol, engineer, Aberdeen. (Fee £5 5s., returnable.)

Bucharest, December 4. — Crossings, for the Roumanian State Railways. The Department of Overseas Trade (Room 50). (Ref. A.X. 2,528.)

Cape Town, December 14.—Plant and material, for the Electricity Supply Commission of Cape Town. The Department of Overseas Trade (Room 52), 35, Old Queen Street, London, S.W.1. (Ref. B.X. 2,139.)

Johannesburg, December 10.—Pig-iron, etc., for the South African Railways and Harbours. The Department of Overseas Trade (Room 48), 35, Old Queen Street, London, S.W.1. (Ref. A.X. 2,356.)

London, S.E., December 1.—Winding drums for cable, etc., for the Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, London, S.E.1.

London, S.W., December 2.—Bogie frames, for the B.B. and C.I. Railway Company. The White Mansion, 91, Petty France, Westminster, London, S.W.1. (Fee £1, non-returnable.)

Peterborough, November 30.—Plant, for the Corporation. Mr. H. A. Nevill, engineer and manager, Electricity Works, Albert Meadow, Peterborough. (Fee £2 2s., returnable.)

Worthing, December 14.—Diesel engine, for the Corporation. The Borough Electrical Engineer, Electricity Works, Worthing.

Personal.

MR. L. WARD, Inspector of Factories, has been appointed to the position of senior engineering inspector at the Home Office.

MR. J. C. WARD has just returned to Sheffield after a year's trip round the world in the interests of his firm, Edgar Allen & Company, Limited.

MR. S. F. SOPWITH, general manager of the Cannock Chase Colliery Company, Limited, has been re-elected president of the South Staffordshire and Warwickshire Institution of Mining Engineers for the ensuing year.

MR. E. J. FOX, managing director of the Stanton Ironworks Company, Limited, near Nottingham, has been the recipient of handsome presentations from the principal officials, the office staff and outside officials, and the members of the various sections of the Welfare Department, on the occasion of his silver wedding.

Wills.

WILD, A. G., founder and managing director of A. G. Wild & Company, Limited, Darnall £7,690

HILL, H. G., of Kenwith Lodge, Durdham Down, Bristol, iron master, and formerly an accountant, a director of Guest, Keen & Nettlefolds, Limited, of John Lysaght, Limited, and of J. & C. Holcroft, Limited, a former chairman of the West of England Munitions Committee £293,983

Fluxing in Cupola Practice.

BY J. H. LIST.

Though the writer takes perhaps what might appear to be an undue interest in this subject, the results he obtained undoubtedly justify the extra attention bestowed. It is patent that even in these enlightened days limestone is put into the cupola in a very haphazard manner. There are furnacemen who state they put limestone on because their predecessors did. Obviously the furnaceman does as he is told, but at the same time a little knowledge imparted to such a man would be advantageous.

The method to be outlined and the formulæ presented are some the writer came by in student days, and for a number of years has put them to good account. The following workings and reasonings may seem to take a long time to arrive at, but the question of fluxing by formula can be reduced to a system in the same manner as mixing the iron charges. Also with the aid of the slide rule and certain appliances the calculation of figures becomes light work. As to when the limestone should be charged, this is really a matter of opinion, the author's practice being to charge after every 4 cwts. of iron. This method ensures an equal distribution amongst the coke passing on each charge. The silicates, being the fundamental basis of the slags, conform to one or more of the following formulæ, in which MO is supposed to represent the metallic oxide compounded with the silicate:—

$2MO + SiO_2 = M_2SiO_4$, a subsilicate.
$2MO + SiO_2 = M_2SiO_4$, a monosilicate.
$MO + SiO_2 = MSiO_3$, a bisilicate.

The bases which correspond to MO are lime (CaO) and magnesia (MgO). The most common base in this group is aluminium, the oxide of which is alumina (Al_2O_3). There are other bases, the oxides of which correspond to the formula M_2O_3.

For these bases the reactions are:—
$2M_2O_3 + 3SiO_2 = M_4Si_3O_{12}$, a subsilicate.
$2M_2O_3 + 3SiO_2 = M_4Si_3O_{12}$, a monosilicate.
$M_2O_3 + 3SiO_2 = M_2Si_3O_9$, a bisilicate.

Quantities of oxygen in the base bear the following proportions to those in the acid in the above silicates:—

	Oxygen in base.	Oxygen in acid.
Subsilicate ...	2	1
Monosilicate ...	1	1
Bisilicate	1	2

The subsilicates are easily fusible, forming a semi-liquid slag. These consolidate easily and split up in so doing. They usually have a dark brown colour, and on account of the large percentage of bases their specific gravities are high.

For the following calculations a coke of average quality has been selected. This contained 8 per cent. of ash, the analysis of which was approximately:—Fe_2O_3, 0.28; Al_2O_3, 4.4; CaO, 0.20; MgO, 0.10; SiO_2, 4.8; and S, 1.0 per cent.

The limestone gave the following approximate analysis:—CaO, 49.75; MgO, 2.08; Fe_2O_3, 0.83; SiO_2, 5.17; CO_2, 41.2; and Al_2O_3, 0.69 per cent.

It is necessary to have pure materials, and the low percentage* of SiO_2 is the criterion. Before commencing it is advisable to determine to what extent the ash in the coke is self-fluxing. We obtain the following, calculating from the molecular weights in the proportion suitable to form a subsilicate:—

$4Fe_2O_3 + 3SiO_2$	640 : 180 : : 0.28 : X	=	0.07
$4Al_2O_3 + 3SiO_2$	411 : 180 : : 4.4 : X	=	1.92
$4CaO + SiO_2$	224 : 60 : : 0.2 : X	=	0.05
$4MgO + SiO_2$	160 : 60 : : 0.1 : X	=	0.03
			2.07

Bases present will flux 2.07 per cent. silicon. Deducting this quantity of silica from that present in the coke, 4.8 − 2.07, leaves 2.73 per cent. still to be fluxed by the lime of the limestone. This then gives the following:—

$SiO_2 + 4CaO = 60 : 224 : : 2.73 : X$.
$X = 10.19$, which is the percentage of CaO necessary.

The sulphur must not be neglected, as it will also require extracting.

$S + CaO$ becomes $32 : 56 : : 1 : X$.
$X = 1.75$ per cent. of lime to be used.

This gives a total of 11.94 as the percentage of lime or pounds to be used to every 100 lbs. of coke. The limestone is not pure, hence it is necessary to use this amount to obtain sufficient calcium oxide. Next determine to what extent the limestone is self-fluxing, as it contains the serious item of 5.17 per cent. silica. The following table gives these calculations:—

	Mol. Wts.	Bases other than CaO.	X	
$4MgO + SiO_2$	= 160 :	60 : : 2.08 : X	=	0.81
$4Al_2O_3 + 3SiO_2$	= 411 :	180 : : 0.69 : X	=	0.03
$4Fe_2O_3 + 3SiO_2$	= 640 :	180 : : 0.83 : X	=	0.23
				1.07

Thus the silica, which is fluxed by bases other than CaO, is 1.07 per cent.

This gives 5.17 − 1.07 = 4.1 silica to be fluxed by the lime in the limestone. Calculating as above, it gives:—

Mol. Wts. SiO CaO
$SiO_2 + 4\ CaO = 60 : 224 : : 4.1 : X$.
Therefore X = 15.30.

As the limestone contains 49.75 CaO
And this calculation gives 15.30

34.45

This leaves for effective work in the limestone only 34.45 per cent. CaO. The item left in the analysis is the CO_2. From this we see that for every 100 lbs. of coke we should want 10.19 + 1.75 = 11.94 parts of pure lime. These calculations show that in 100 lbs. of limestone there are only available 34.45 parts of lime, and so it will be necessary to calculate the amount of limestone required thus:—

$34.45 : 100 : : 11.94 : X$.
$X = 34.64$.

Thus it has been shown that in the case chosen for every 100 lbs. of coke 34.65 lbs. of limestone must be used.

[Whilst the above calculations show the method to be employed, it should be pointed out that the author has taken no cognisance of the sand (silica) adhering to the pig or the rust (hydrated iron oxide) to be associated with all cupola charges. We consider that the silica in the limestone should be specified not to exceed 2.5 per cent.—EDITOR.]

*The SiO_2 content of 5.17 per cent. is too high to be considered the best practice.—Editor.

Perlit Iron.

According to the Liverpool Chamber of Commerce Journal, more and more interest is being taken in Perlit iron, as the various experimental uses for which it is being employed give satisfactory results, and show that the claims which have been made for it are justified. Messrs. Burmeister and Wain, of Copenhagen, the largest manufacturers and pioneer constructors of the Diesel engine, and who for many years have been improving the quality of their cast, are manufacturing all Perlit iron, and in future it is understood that all castings in the B. and W. Diesel made at Copenhagen will be cast of this iron.

At least two foundries in Liverpool and district are producing, or about to produce, this iron on a commercial basis, and the forecast that Perlit iron was a valuable stepping stone in the iron industry and one which may increase the percentage of iron castings in iron and steel castings generally, would appear to be justified, and in the result the same situation is likely to be created as has occurred between Thomas steel and Siemen-Martin steel. For those industries where quality is of importance Perlit iron will be supplied to definite specifications, with the additional advantage that the cost will be little more than that of the present material, which so often one gets under the name of cast-iron.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Although the majority of consumers have already provided for their requirements over the remainder of the year, there is still a fairly satisfactory demand for Cleveland iron in the market, with forward buying much more active than has been experienced for a good many months past. As a matter of fact, some business has been fixed up as far forward as June next. Consequently, with brighter prospects both in the home markets and abroad, the Cleveland makers are less disposed than ever to make any price concessions, and 68s. per ton is firmly quoted for No. 1 foundry iron, 66s. for No. 3 Cleveland G.M.B., 65s. for No. 4 foundry, and 64s. 6d. for No. 4 forge.

As evidencing the growing strength of the Tees-side hematite industry, it may be noted that before the end of the month three more Middlesbrough blast furnaces will be lighted up, and their output will help to relieve the situation. But at the moment supplies are scarce. Certainly prompt iron is not easy to obtain, and producers are selling forward at 75s. per ton for East Coast mixed numbers and 75s. 6d. for No. 1. On the North-West Coast prices are also firmer, Bessemer mixed numbers being quoted at £4 1s. 6d. c.i.f. Welsh ports, £4 4s. per ton delivered at Glasgow, £4 7s. per ton delivered at Sheffield, and £4 12s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—The local demand for foundry pig, though not quite so active, is fairly steady, sellers of Derbyshire No. 3 iron holding very firmly at 73s. 6d. per ton delivered in Manchester and the neighbourhood, and one does not hear that anything less has been accepted. The demand for Scotch iron in Manchester is rather better, but the prices are about the same as they were.

THE MIDLANDS.—In South Staffordshire and neighbouring markets the chief consumers are apparently the makers of light castings, who, in the main, are now covered for their requirements up to the end of the year; in isolated cases some are contracted a month or so beyond this. Ruling prices are as follow:—Derbyshire No. 3 foundry, 65s.; Staffordshire No. 3 foundry, 65s.; Northants. No. 3 foundry, 62s. 6d.

SCOTLAND.—Business in local markets for foundry pig progresses very slowly towards recovery, transactions of any bulk having of late been few and far between. The price for No. 3 foundry is not more than 78s. at the furnaces, and the makers can quite easily be induced to break this price, especially for a round parcel.

Finished Iron.

This is still the most disappointing section of the whole market. Activity does not increase as much as could be wished, particularly as regards crown and commoner qualities. Both are subject to a great deal of competition from home producers, and, in the case of the commoner qualities, from abroad also. Continental bars can still be obtained at about £4 below the local quotation.

Scrap.

An increasing demand for pig-iron has been followed to a limited extent in Lancashire by a similar movement in markets for scrap metal, and the inquiry is growing a little. It is generally admitted that the foundries, or many of them, have rather more work in hand, and consequently more cast scrap is required for mixing purposes, and as it is a comparatively cheap material, the foundries are using more. For good broken machinery scrap dealers quote 72s. 6d. per ton delivered, and in some cases are asking more than this. One sale at least has been reported at 75s. There is, of course, some common scrap to be had at 70s. per ton. Demand for foundry scrap in Scotland remains quiet, but some quantities of cast-iron borings have been disposed of recently at 46s. 6d. to 47s. 6d. per ton. Machinery cast-iron scrap still remains unchanged at 70s. to 71s. 3d. per ton.

Metals.

Copper.—Though the tendency of values for standard copper are admittedly lower, business in the non-ferrous metals is generally steady, with consumptive demand in a fairly steady condition. So far as the copper consuming industries are concerned, slow but sustained progress is apparent. No doubt the rapid development of the motor-car and cycle industries has been the principal cause of the movement, but other branches of engineering have helped. Current quotations:—*Cash*: Thursday, £60 17s. 6d.; Friday, £60 15s.; Monday, £60 7s. 6d.; Tuesday, £60; Wednesday, £60 2s. 6d.

Three Months: Thursday, £61 15s.; Friday, £61 15s.; Monday, £61 7s. 6d.; Tuesday, £61; Wednesday, £61 2s. 6d.

Tin.—A strong statistical position having been established in this section of the market, the weekly records of business done all point to a higher standard of values to come, and fluctuations are almost invariably in an upward direction. While the course of the market in some degree depends on technical conditions, and whatever manipulation may be indulged in, in the event of a lull in the American demand, there is little doubt that tin will be selling at a still higher range of prices later. Current quotations:—*Cash*: Thursday, £286; Friday, £286 2s. 6d.; Monday, £287; Tuesday, £282 10s.; Wednesday, £285 5s.

Three Months: Thursday, £282 10s.; Friday, £282 10s.; Monday, £281 10s.; Tuesday, £278 10s.; Wednesday, £280.

Spelter.—Offerings of late have been heavy, but the demand is quite good. News has been received from Norway from engineers recently returned from Spitsbergen that valuable deposits of zinc ore have been found on the properties of the Northern Exploration Company and Norwegian companies in Spitsbergen. It is further stated that preliminary shipments have already been made, and realised excellent prices. Current quotations:—*Ordinary*: Thursday, £38 6s. 3d.; Friday, £38 15s.; Monday, £39 1s. 3d.; Tuesday, £39 10s.; Wednesday, £39 10s.

Lead.—In the market for soft foreign pig the recent fall in prices has more particularly affected near delivery; but forward metal has also depreciated. So far as can be gathered, the world production is meeting requirements, although the fact must not be overlooked that consumption in the States continues heavy, so that offers of American lead to European ports have remained on the light side. Current quotations:—*Soft foreign (prompt)*: Thursday, £36 10s.; Friday, £36 13s. 9d.; Monday, £36 10s.; Tuesday, £36; Wednesday, £35 15s.

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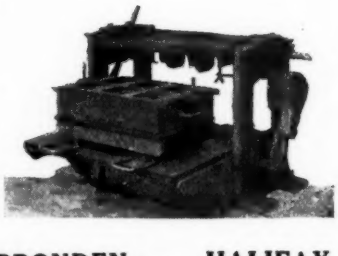
SIMPLE, SUBSTANTIAL, ACCURATE.

MODEST IN PRICE.

STANDARD SIZE
Takes Boxes up to 24″×18″×8″



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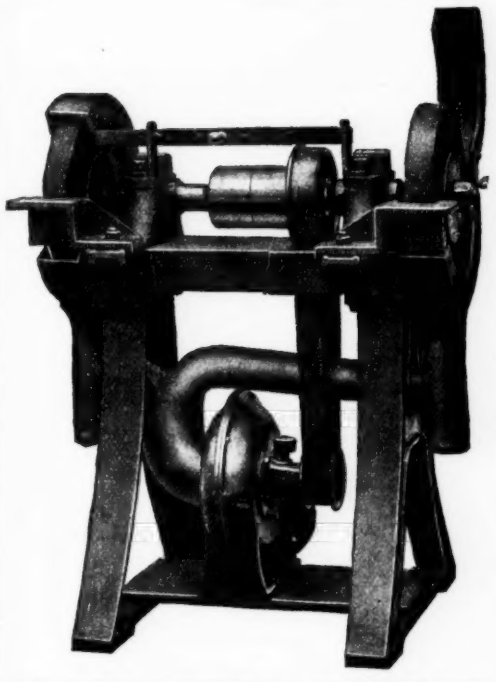

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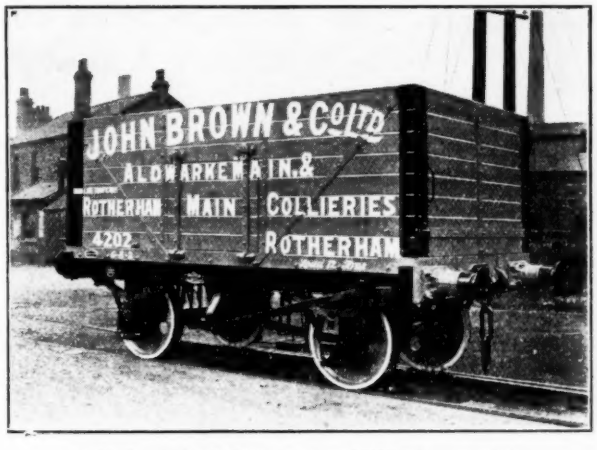

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	Tons	*cwts.*	*qrs.*	*lbs.*
TARE with Tyred Wheels was	6	12	2	0
TARE with DAVIS WHEELS is	6	8	3	0

REDUCTION in TARE by fitting DAVIS WHEELS is
3 cwts. 3 qrs. for a 12-ton Wagon. 6 cwts. to 8 cwts. for a 20-ton Wagon.

THINK what this means in the cost of haulage, etc.

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ATLAS WORKS, SHEFFIELD.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	60	2	6
Three months	61	2	6
Electrolytic	66	15	0
Tough	62	15	0
Best selected	63	15	0
Sheets	92	0	0
India	79	0	0
Wire bars	67	5	0
Do. Dec.-Jan.	67	0	0
Do. Jan.	67	0	0
Ingot bars	67	0	0
H.C. wire rods	71	10	0
Off. av. cash, Oct. 62	0	9	9/11
Do., 3 mths. Oct. 62	18	9	
Do., Sttlmnt, Oct. 62	0	6	9/11
Do., Electro, Oct. 67	14	3	9/11
Do., B.S., Oct.	65	1	11½
Aver. spot price copper, Oct.	62	0	6¾
Do., wire bars, Oct.	67	18	2½

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10d.

BRASS.

Solid drawn tubes 12d.
Brazed tubes 13½d.
Rods, drawn 11½d.
Rods, extd. or rlld. 7½d.
Sheets to 10 w.g 10½d.
Wire 10½d.
Rolled metal 10½d.
Yellow metal rods 7½d.
Do. 4 × 4 Squares 8d.
Do. 4 × 3 Sheets 8½d.

TIN.

Standard cash	285	5	0
Three months	280	0	0
English	285	10	0
Bars	285	0	0
Straits	289	15	0
Australian	277	15	0
Eastern	290	15	0
Banca	291	5	0
Off.aver. cash, Oct.	277	17	3/11
Do., 3 mths., Oct.	278	0	11 1/2
Do., Sttlmt. Oct.	277	16	9/11
Aver. spot., Oct.	277	16	9½

SPELTER.

Ordinary	39	10	0
Remelted	37	10	0
Hard	32	15	0
Electro 99.9	43	12	6
English	40	2	6
India	33	15	0
Zinc dust	45	0	0
Zinc ashes	15	0	0
Off. aver., Oct.	39	5	4 1/2
Aver., spot, Oct.	39	17	8

LEAD.

Soft foreign ppt.	35	15	0
English	37	0	0
Off. average, Oct.	37	19	0¾
Average spot, Oct.	39	0	4

ZINC SHEETS, &c.

Zinc sheets, English	46	10	0
Do. V.M. ex whf.	45	10	0
Rods	53	0	0
Boiler plates	44	10	0
Battery plates	45	0	0

ANTIMONY.

Special brands. Eng.	89	10	0
Chinese	81	0	0
Crude	63	0	0

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FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon
45/50% 11 15 6
75% 21 10 0
Ferro-vanadium—
35/40% 16/- lb. va.
Ferro-molybdenum—
70/75% c. free 6/3 lb.
Ferro-titanium—
23/25% carbonless 1/1 lb.
Ferro-phosphorus, 20/25%, £22 0 0
Ferro-tungsten—
80/85%,c.fr. 1/7½ to 1/8 lb.
Tungsten metal powder—
98/99% 1/10½ to 1/11lb.
Ferro-chrome—
4/6% car. £23 12 6
6/8% car. £23 2 6
8/10% car. £22 15 0
Ferro-chrome—
Max. 2% car. £41 0 0
Max. 1% car. £49 10 0
Max.0.70%car. £56 10 0
70%, carbonless 1/5 lb.
Nickel—99%,
cubes or pellets £172 to £177
Cobalt metal—98/99% 10/- lb.
Aluminium 98/99% £120
Metallic Chromium—
96/98% 3/9 lb.
Ferro-manganese (net)—
76/80%, loose £15 7 6
76/80%, packed £16 7 6
76/80%, export £15 5 0
Metallic manganese—
94/96%, carbonless 2/- lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten 2 6
Finished bars, 18% tungsten 3 6
Per lb. net, d/d buyers' works.
Extras—
Rounds and squares 3 in. and over 4d.lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Do. under ¼in. to 3/16 in. 1/- lb.
Flats, ½in. × ¼in. to under 1 in. × ⅜ in. 3d. lb.
Do. under ½in. × ¼in. 1/- lb
Bevels of approved sizes and sections 6d. lb.
Bars cut to length 10% extra
Scrap from high-speed tool steel—
Scrap pieces 3d.
Turningds andwarf 1d.
Per lb. net, d/s steel makers' work

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Hvy. steel	3	8	6	to 3	12	6	
Bundled steel & shrngs.	3	2	6	to 3	6	6	
Mixed iron & steel	3	2	6	to 3	5	0	
Heavy cast iron	3	5	0	to 3	6	0	
Good machinery for foundries	3	10	0	to 3	12	6	
Cleveland—							
Heavy steel	3	0	0				
Steel turnings	1	17	6				
Cast iron borings	1	15	0				
Heavy forge	4	2	6				
Bushelled scrap	3	0	0				
Cast-iron scrap	3	0	0	to 3	1	0	
Lancashire—							
Cast-iron scrap	3	10	0	to 3	12	6	
Heavy wrought	3	5	0	to 3	7	6	
Steel turnings	2	0	0				
London — Merchants' buying prices delivered yard.							
Copper (clean)	53	0	0				
Brass (clean)	40	0	0				
Lead (less usual draft)	33	0	0				
Tea lead	29	0	0				
Zinc	27	0	0				
New aluminium cuttings	92	0	0				
Braziery copper	48	0	0				
Gunmetal	47	0	0				
Hollow pewter	195	0	0				
Shaped black pewter	142	0	0				

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N.E. Coast—
Foundry No. 1 68/-
Foundry No. 3 66/-
Foundry No. 4 65/-
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Hematite No. 1 75/6
Hematite M/Nos. 75/-
N.W. Coast—
Hem. M/Nos. d/d Glas. 84/-
,, d/d Birm. 92/6
Midlands—
Staffs common* —
,, No. 4 forge 59/6
,, No. 3 foundry 65/-
Shrops. basic 70/-
,, Cold blast, ord.* 185/-
,, ,, roll iron* 190/-
* d/d Birmingham.
Northants forge 56/-
,, fdry No. 3 62/6
Derbyshire forge 58/6
,, fdry. No. 3 65/-
,, basic 65/-
Scotland—
Foundry No. 1 83/-
,, No. 3 78/-
Hem. M/Nos. 78/-
Sheffield (d/d district)—
Derby forge 62/6
,, fdry. No. 3 68/-
Lincs. forge 67/-
,, fdry. No. 3 69/6
E.C. hematite 85/6
W.C. hematite 88/6
Lincs. (at furnaces)—
Forge No. 4 61/-
Foundry No. 3 63/6
Basic 65/6
Lancashire (d/d eq. Man.)—
Derby forge 66/-
,, fdry. No. 3 73/6
Northants foundry No. 3 75/3
Dalzell, No. 3 110/-
Summerlee, No. 3 95/6
Glengarnock, No. 3 95/6
Gartsherrie, No. 3 95/6
Monkland No. 3 95/6
Coltness, No. 3 95/6
Shotts, No. 3 95/6

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Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars(cr.)	11	5	0	to 12	10	0	
Angles				11	10	0	
Tees to 3 united ins.				12	0	0	
Nut and bolt				11	0	0	
Hoops	14	0	0	to 15	0	0	
Marked bars (Staffs.) f.o.t.				14	10	0	
Gas strip	12	10	0	to 12	15	0	
Bolts and nuts ¾ in. × 4 in.				16	15	0	
Steel—							
Ship plates	7	5	0	to 8	7	6	
Boiler plts.				11	10	0	
Chequer plts.	£9	5	0	to 9	15	0	
Angles	£7	0	0	to 7	10	0	
Tees	£8	5	0	to 8	10	0	
Channels	£6	17	6	to 7	7	6	
Joists	£7	0	0	to 7	10	0	
Rounds and Squares 3 in. to 5½ ins.				8	10	0	
Rounds under 3 in. to ¾ in.				8	5	0	
Flats, over 5 in. wide and up				9	0	0	
Flats, 5in. to 1½in.				8	0	0	
Rails, heavy				8	0	0	
Fishplates				12	10	0	
Hoops (Staffs.)				10	10	0	
Black sheets, 24g.	11	5	0				
Galv. cor. sheets, 24g.				16	12	6	
Galv. fencing wire 8g. plain				14	0	0	
Billets,soft	£6	0	0	to 7	10	0	
Billets, hard				8	12	6	
Sheet bars				6	5	0	
Tin bars d/d				6	5	0	

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3½
Wire	1	4
Rods	1	3
Tubes	1	8½
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

Per lb.
Ingots for raising 9d. to 1/3
Rolled—
To 9 in. wide 1/3 to 1/9
To 12 in. wide 1/3½ to 1/9½
To 15 in. wide 1/3½ to 1/9½
To 18 in. wide 1/4 to 1/10
To 21 in. wide 1/4½ to 1/10½
To 25 in. wide 1/5 to 1/11
Ingots for spoons and forks 9d. to 1/5½
Ingots rolled to spoon size 1/- to 1/8½
Wire round—
3/0 to 10 G. 1/6½ to 2/1½
with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated. Dols.

No. 2X foundry, Phila.	23.76
No. 2 foundry, Valley	22.26
No. 2 foundry, Birm.	21.00
Basic	21.76
Bessemer	22.76
Malleable	22.26
Grey forge	21.76
Ferro-mang. 80% d/d	115.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	34.00
O.-h. billets	34.00
O.-h. sheet bars	35.00
Wire rods	45.00

Cents.

Iron bars, Phila.	2.12
Steel bars	2.00
Tank plates	1.85
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.50
Sheets, black, No. 28	3.25
Sheets, galv., No. 28	4.50
Sheets, blue an'l'd, 9 & 10	2.40
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplate, 100 lb. box	£5.50

COKE (at ovens).

Welsh foundry 32/6 to 37/6
,, furnace 20/- to 25/-
Durham & North.
,, foundry 30/- to 33/-
,, furnace 15/3 to 15/9
Other Districts, foundry 30/- to 33/-
,, ,, furnace (basis) 11/9

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	20/-
,,	28×20, ,,	40/-
,,	20×10, ,,	29/7½
,,	18¾×14, ,,	20/10½
C.W.	20×14, ,,	18/1½
,,	28×20, ,,	36/3
,,	20×10, ,,	25/4½
,,	18¾×14, ,,	18/7½

Terneplates 28 × 20, 36/3 per box basis f.o.b.

SWEDISH IRON.

Bars, hammered £19/0 to £20/0
Rolled Ord. £16/0/0 to £16/10/0
Nail rods £16 5 0 to £16 15 0
Keg. steel nom. £33 to £35
Faggot steel nom. £22 to £25
Blooms, according to quality £10 to £14
Pig-iron £6 15 0 to £7 0 0 all f.o.b. Gothenburg.

TUBES.

Up to and incl. 6 in.

Gas .. 55% } Tube prices
Water .. 50% } are
Steam .. 45% } now free.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.	
Nov. 19	60	17	6	dec. 2/6
,, 20	60	15	0	,, 2/6
,, 23	60	7	6	,, 7/6
,, 24	60	0	0	,, 7/6
,, 25	60	2	6	inc. 2/6

Electrolytic Copper.

	£	s.	d.	
Nov. 19	67	10	0	No change
,, 20	67	5	0	dec. 5/-
,, 23	67	0	0	,, 5/-
,, 24	66	15	0	,, 5/-
,, 25	66	15	0	No change

Standard Tin (Cash).

	£	s.	d.	
Nov. 19	286	0	0	dec. 20/-
,, 20	286	2	6	inc. 2/6
,, 23	287	0	0	,, 17/6
,, 24	282	10	0	dec. 90/-
,, 25	285	5	0	inc. 55/-

Tin (English ingots).

	£	s.	d.	
Nov. 19	286	0	0	dec. 20/-
,, 20	286	5	0	inc. 5/-
,, 23	287	0	0	,, 15/-
,, 24	283	0	0	dec. 80/-
,, 25	285	10	0	inc. 50 -

Zinc Sheets (English).

	£	s.	d.	
Nov. 19	46	10	0	No change
,, 20	46	10	0	,, ,,
,, 23	46	10	0	,, ,,
,, 24	46	10	0	,, ,,
,, 25	46	10	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
Nov. 19	38	6	3	inc. 6/3
,, 20	38	15	0	,, 8/9
,, 23	39	1	3	,, 6/3
,, 24	39	10	0	,, 8/9
,, 25	39	10	0	No change

Lead (English).

	£	s.	d.	
Nov. 19	38	0	0	No change
,, 20	38	0	0	,, ,,
,, 23	37	15	0	dec. 5/-
,, 24	37	5	0	,, 10/-
,, 25	37	0	0	,, 5/-

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS.

Year.	Jan	Feb	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1885	44 0	44 1	43 2	43 1	42 10	42 6	42 6	42 0	42 2	42 1	43 0	43 8	42 11½
1886	43 3½	42 0	42 0	41 6½	41 2½	40 0	40 0	41 2½	41 6	44 0	44 0	44 9	42 2½
1887	49 6	48 9½	45 6	43 2½	43 6½	44 1	44 0	44 2½	43 5½	41 6	41 9½	45 0	44 6½
1888	44 4	42 3	42 1½	42 0	41 2½	42 1½	42 6½	44 0	45 8½	44 6	44 6	45 3½	43 4
1889	44 4	45 2	47 3½	48 9½	48 6½	48 7½	50 1½	53 11	55 3	63 6	73 10	73 2	54 4½
1890	76 1½	65 1	63 3	55 1	53 9½	50 11	52 3½	56 4	58 0	58 2	57 5	54 4½	58 5
1891	52 9	50 10	48 11	47 9½	51 5	50 6	50 10	48 4	50 1	49 1½	48 3½	47 8	49 8½
1892	47 4	45 6	46 4½	47 8	49 5	50 4½	49 7½	49 10½	49 10½	48 8½	46 10	46 1½	48 2½
1893	46 0½	45 8	45 11	45 7	44 11	44 9½	44 10	45 3	45 0	44 6	44 7	45 8	45 3
1894	45 3	45 3	45 1½	45 1	43 11	43 11	43 9½	44 2	44 7½	43 7	43 5	43 3	44 3½
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	50 1	50 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1½
1923	109 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 0	—	—

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SAND MIXERS.—New and second-hand. Ask us to quote.—W. BREALEY & COMPANY, LTD., Russell Street, Sheffield.

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Nearly New No. 2 Robey, Smith AUTOMATIC BEVEL GEAR PLANER, by Smith & Coventry.

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No. 38 BROACHING MACHINE, by J. N. Lapointe; capacity side of broach, 3½ in.; stroke, 56 in.

10-in. Stroke SLOTTING MACHINE, by G. F. Smith; table, 24 in. diam.; minimum depth of gap, 15 in.

FOUR LANCASHIRE BOILERS, 30 ft. x 8 ft.; reinsure 150 lbs. pressure.

Two very good Dish-ended LANCASHIRE BOILERS, by Thompson; 30 ft. x 8 ft.; reinsure for 140 lbs. per sq. inch working pressure; ready for dispatch.

TWO VERTICAL COCHRAN LAND-TYPE BOILERS, 14 ft. high x 7 ft. diam; new in 1917; heating surface about 500 sq. ft. per boiler; 100 lbs. working pressure.

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